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THE GENUS *CODIUM* (CHLOROPHYTA) IN SOUTH AFRICA

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(With Plates II–XVI)

SUMMARY

Nineteen species of *Codium* occur along the coast of South Africa and adjacent Mozambique. Each species is described and illustrated in detail, and notes on distribution and habitat are given. Twelve taxa are newly proposed.

INTRODUCTION

The representation of *Codium* in South Africa is rich both in number of species and in the spectrum of variation. A study of *Codium* in only three other areas—Australia, Japan, and Pacific Mexico—could give as complete a picture of the genus. It has been a great pleasure to undertake this investigation. The original blocking-out of species was completed in 1951 as part of a doctoral dissertation at the University of California under the inspirational guidance of Professor G. F. Papenfuss, who, with characteristic generosity, made all of his collections available, together with those of the University of Cape Town ecological surveys of 1937–1940, which had been sent to him for identification. Accumulation of vast quantities of *Codium* from the far corners of the world, for which I am indebted to scores of collectors, necessitated several reviews of the South African representatives. Miss M. A. Pocock (Rhodes University, Grahamstown), whose South African collections were well represented in material that I studied at Berkeley, in 1953 sent me the largest and best prepared series of collections of *Codium* that I have ever been privileged to study. During the final review of *Codium* in South Africa, Professor W. E. Isaac kindly sent me useful sets of liquid-preserved and dried specimens. The present paper is a taxonomic treatment of those species found along the South African coast from the Orange River on the Atlantic Ocean southward around the Cape of Good Hope and northeastward to the Limpopo River, Mozambique. Ontogenetic and phylogenetic considerations, which constituted an important part of my doctoral dissertation, have been omitted in large part; they will be presented in a comprehensive systematic account of the entire genus to be published after completion of studies of various geographical groups of species.

HISTORICAL REVIEW

A brief history of *Codium* in South Africa is not only interesting in itself, but it affords an opportunity to give credit to those whose efforts preceded mine. Early collectors returned with examples of most of the common species, which were assigned to one or another European species on the basis of external morphology. Thus, *C. stephensiae* and *C. lucasii* subsp. *capense* were referred to *C. adhaerens*; *C. capitatum*, *C. duthieae*, *C. extricatum*, *C. fragile* subsp. *capense*, and *C. isaacii* to *C. tomentosum*; and *C. platylobium* at times to *C. elongatum*. Prior to 1935 only three endemic species had been described (*C. platylobium*, 1854; *C. tenue*, 1856; *C. stephensiae*, 1932). The richness of South African *Codium* nonetheless was recognized by W. A. Setchell (University of California), who during the period approximately 1925–1935 accumulated large quantities of specimens and information in pursuing his aim to monograph the entire genus. Setchell himself collected in South Africa in 1927 and additional South African material was sent to him by Miss E. Forbes and Miss A. V. Duthie. From his notes, it is clear that he recognized many of the novelties that are described herein, but largely because he was using dried specimens rather than liquid-preserved material, most of Setchell's manuscript species encompassed parts of two or more species. The ecological surveys made by the Zoology Department of the University of Cape Town under the direction of Professor T. A. Stephenson served as a stimulus to the study of *Codium* by providing many excellent collections. Professor Papenfuss identified the collections of 1937–1940 and, like Setchell, recognized many of the new species described in this paper.

EXPLANATION OF FORMAT

An attempt has been made to check all references to South African *Codium* by examining specimens upon which the records were based. Records thus checked appear under the proper species, and the specimen upon which the record was based is cited, or an alternative basis for identification is indicated (e.g., inference from description or locality). Records listed without supporting citations of specimens are those which I deem reliable in consideration both of the reliability of the author and of the distinctness of the species. Records for which specimens have been sought but have not been located are listed at the end of the paper.

Excluded records are documented in a similar manner. All records of European species (i.e., *C. adhaerens*, *C. bursa*, *C. decorticatum* [=*C. elongatum*], and *C. tomentosum* [=*C. dichotomum*]) may safely be excluded.

The lists of representative collections examined are intended to convey details of geographic distribution. Collections are listed geographically in counterclockwise order from South West Africa around the Cape to Mozambique. River mouths refer to rocky outcrops or headlands near the actual mouths except in the case of *Codium tenue*, which grows in estuarine environments. Herbaria are abbreviated as follows: AD (State Herbarium of South Australia, Adelaide); AG (Agardh Herbarium, housed in the Botanical Museum, Lund); B (Botanisches Museum, Berlin); BM (British Museum [Natural History]); BOL (Bolus Herbarium incorporated into the Department of Botany, University of Cape Town, in 1955); CT (Department of Botany, University of Cape Town); FI (Istituto Botanico, Firenze); G (Conservatoire et Jardin botaniques, Genève); HBG (Staatsinstitut für allgemeine Botanik, Hamburg); K (Royal Botanic Gardens, Kew); L (Rijksherbarium, Leiden); M (Botanische Staatssammlung, München); MAP (personal herbarium of M. A. Pocock, eventually to be incorporated into the Herbarium of the Albany Museum, Grahamstown); NY (New York Botanical Garden); PC (Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris); RU (Rhodes University, Grahamstown); S (Naturhistoriska Riksmuseum, Stockholm); SAP (Botanical Institute, Hokkaido University, Sapporo); TCD (Trinity College, Dublin); UC (University of California, Berkeley); W (Naturhistorisches Museum, Wien); WEI (personal herbarium of W. E. Isaac); WU (Botanisches Institut der Universität Wien). All collections (or specimens) for which no herbarium abbreviation is given are housed at the University of California. Miss Pocock's and Professor Isaac's collections, except as otherwise indicated, are represented in their personal herbaria, whether or not duplicates have been deposited at Berkeley. The original set of the Ecological Survey collections is now housed in the Department of Botany, University of Cape Town. Duplicates from the 1937–1940 surveys have been deposited at Berkeley.

ACKNOWLEDGMENTS

I am indebted to the directors and curators of the herbaria listed above for their splendid co-operation in making historically and taxonomically important specimens available for study. My appreciation to Professor Papenfuss, Professor Isaac, and Dr. Pocock cannot be adequately expressed. Dr. Hannah Croasdale of Dartmouth College has kindly prepared the Latin diagnoses.

Key to Species of Codium in South Africa.

1. Thallus applanate, pulvinate, subglobose, or (if epiphytic) with orbicular foliose excrescences	2.
1. Thallus dichotomously branched, prostrate or erect	12.
2. Thallus applanate, pulvinate, or (if epiphytic) with orbicular foliose excrescences	3.
2. Thallus subglobose	11.
3. Thallus saxicolous	4.
3. Thallus epiphytic (especially on *Cymodocea*)	10.
4. Apices of utricles acuminate	1. *C. acuminatum*
4. Apices of utricles rounded or truncate, not acuminate	5.
5. Thallus membraniform, 1·5—3 mm. thick, loosely attached to substratum	9. *C. pelliculare*
5. Thallus felt-like, mostly thicker than 3 mm., firmly attached to substratum	6.
6. Utricles mostly less than 105 μ diam.	7.
6. Utricles mostly greater than 105 μ diam.	8.
7. Thallus with well developed more or less free lobes; utricles markedly ninepin shaped	4. *C. stephensiae.*
7. Thallus with free edges, but without free lobes; utricles not markedly ninepin shaped	3. *C. lucasii* subsp. *capense.*
8. Thallus pulvinate; utricles mostly longer than 1·8 mm.	6. *C. spongiosum.*
8. Thallus applanate or convoluted; utricles mostly or entirely shorter than 1·8 mm.	9.
9. Thallus applanate; utricles mostly longer than 1 mm.	5. *C. incognitum.*
9. Thallus convoluted; utricles mostly shorter than 1 mm.	2. *C. mozambiquense.*
10. Thallus relatively firm; utricles mostly less than 105 μ diam.	3. *C. lucasii* subsp. *capense.*
10. Thallus very soft; utricles mostly greater than 105 μ diam.	2. *C. mozambiquense.*
11. Utricles in small clusters, mostly 330—520 μ diam. at apex	7. *C. papenfussii.*
11. Utricles mostly single, mostly 1·5—2·7 mm. diam.	8. *C. megalophysum.*
12. Thallus repent (rarely erect), branches intricate and anastomosing	11. *C. prostratum.*
12. Thallus erect, branches not anastomosing	13.
13. Thallus foliaceous	10. *C. platylobium.*
13. Thallus terete or complanate, not foliaceous	14.

14. Apices of utricles mucronate	19. *C. fragile* subsp. *capense.*
14. Apices of utricles not mucronate	15.
15. Utricles often longer than 1 mm.	17. *C. duthieae.*
15. Utricles rarely as long as 1 mm.	16.
16. Utricles often capitate (milk-bottle shaped), apices externally foveolate	12. *C. capitatum.*
16. Utricles not capitate, apices not externally foveolate	17.
17. Utricles very slender, clavate, with markedly and usually asymmetrically thickened apices	13. *C. pocockiae.*
17. Utricles stout, cylindrical to turbinate, apices not asymmetrically thickened..	18.
18. Utricles cylindrical to slightly clavate, mostly 125—280 μ diam.	16. *C. extricatum.*
18. Utricles sometimes cylindrical, but more often markedly clavate, pyriform, or turbinate, commonly 200—400 μ diam.	19.
19. Distal parts of thallus tenuous; hair scars not abundant, usually one per utricle	14. *C. tenue.*
19. Distal parts of thallus not tenuous; hair scars either absent or abundant	20.
20. Hair scars abundant, usually several to many per utricle; apices subtruncate	15. *C. cicatrix.*
20. Hair scars absent; apices rounded	18. *C. isaacii.*

1. **Codium acuminatum** O. C. Schmidt, Bibl. Bot. 23 (91): 31, fig. 12 (1923). Pocock 1958, p. 25. [Fig. 1]

Thallus applanate, irregular in outline, closely adherent to substratum, very soft, 5—8 mm. thick. Utricles in large compound clusters, usually cylindrical, rarely slightly clavate (40—) 70—150 (—165) μ diam., (455—) 540—950 μ long (measured from apex to point of origin on parent utricle), size proportional to order of branching; primary utricles 155—225 μ diam., to 1·3 mm. long; utricles of final order of branching often not developing medullary filaments; apices moderately to very sharply pointed; utricular wall about 1·5 μ thick, at apex thickened to as much as 7·5 μ, prolonged into mucro in sharply pointed utricles; mucro often scalariform (chambered), to 50 μ long. Hairs (or hair scars) common on older utricles, to 10 per utricle, borne at broadest part of utricle (125—220 μ below apex). Medullary filaments mostly 21—35 μ diam. Gametangia lance-ovoid, ellipsoidal, fusiform, or oblance-ovoid, 47—82 μ diam., 165—270 μ long, 1 (—2) per utricle, each borne on short pedicel (5—8 μ long) below middle of utricle (410—525 μ below apex).

Type.—Tamatave, Madagascar, 1904, *Voeltzkow.* The holotype in the Botanisches Museum, Berlin, was destroyed by fire on March 1, 1943. Fortunately, a fragment of the holotype had previously been sent to Setchell by Schmidt and is now in the Herbarium of the University of California.

Other Collection Examined.—MOZAMBIQUE. Cabo Inhaca, on tufts of small corallines (*Jania* and *Amphiroa*) on floor of large pool in low

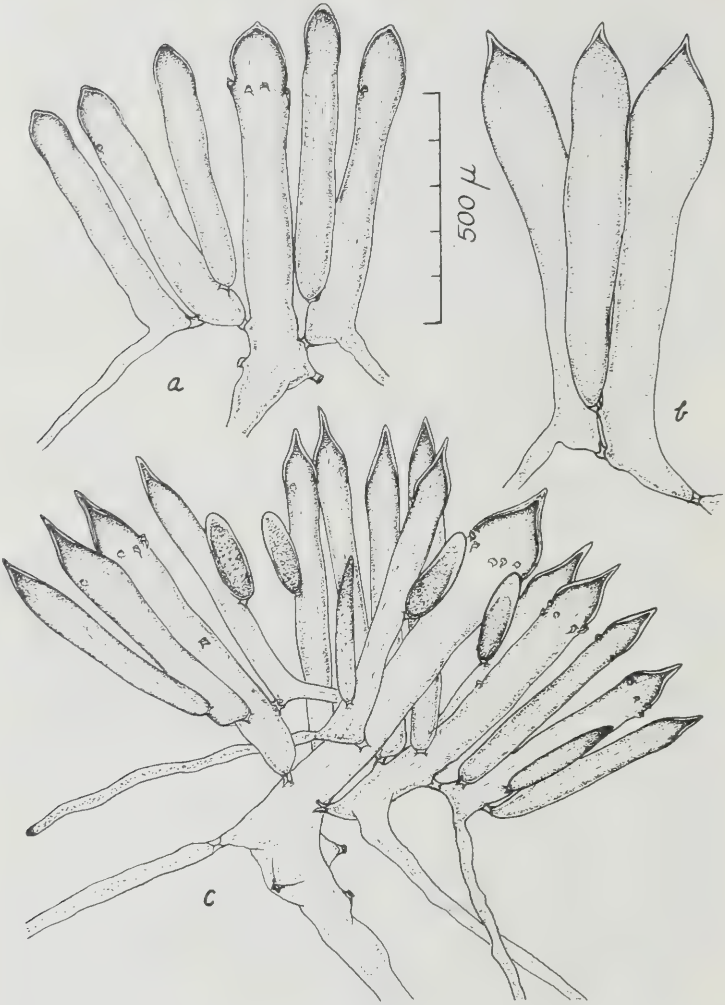

Fig. 1.—*C. acuminatum*. *a* (Tamatave, Madagascar, *Voeltzkow*=type), mature group of utricles from centre of thallus; *b*, *c* (Cabo Inhaca, Mozambique, *Pocock 12290*): *b*, mature group of utricles from edge of thallus; *c*, mature group of utricles from centre of thallus.

tide terrace, in company with *C. mozambiquense*, *C. lucasii* subsp. *capense*, *C. prostratum*, and *C. pocockiae*, rare, 26.ix.1957, *Pocock 12290*.

The rediscovery of this highly distinctive species, previously known only from the type collection, underscores the remarkable collecting skill of Miss Pocock. The Cabo Inhaca material is especially important because it is fertile, the type collection being sterile. The apices of utricles of the Cabo Inhaca plants are sharply pointed in contrast to the bluntly pointed utricles of the type specimen. This range of variation is to be expected, however, and undoubtedly results from environmental and age differences as well as from genic differences.

Schmidt indicated a close relationship between *C. acuminatum* and *C. arabicum* Kuetzing, a belief with which I am in full accord. It is probably still more closely related to *C. mozambiquense.* Growing in association with other adherent *Codium*, it resembles *C. mozambiquense,* and thereby differs from *C. lucasii* subsp. *capense,* in its very soft texture.

2. **Codium mozambiquense** sp. nov. [Fig. 2, Plate II, *a*]

Previous Record.—Pocock 1958, p. 25, as *Codium* sp.

Thallus conduplicatus, substratum (stipites *Cymodoceae*, particulas corallini defuncti) implicans, convolutus, mollis, excrescentias orbiculares foliosas ad 6 cm. lat. habens. Utriculi multum fastigiati, (90—) 100—190 (—275) μ diam., 510—1,050 μ long. (an apice ad locum originis in utriculo parenti metati), magnitudine ad ordinem ramificationis pro portione;

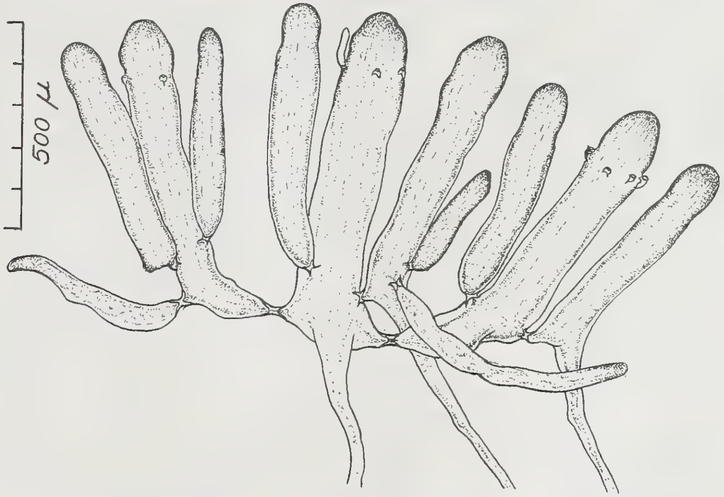

FIG. 2.—*C. mozambiquense* (Ponta Rasa, Mozambique, *Pocock 12268*=type). Mature group of utricles from centre of thallus.

utriculi primarii 190—275 μ diam., ad 1·5 mm. long.; utriculi ultimi ordinis ramificationis filamenta medullaria saepe non evolventes; utriculi cylindrici ad paulum clavatos, in regione 100—130 μ infra apicem (admodum super zonam cicatricum pilorum) aliquantulum constricti; cacumina apicum rotundata, lateribus saepe complanatis depressisve; membrana utriculari 1·5—2 μ crassa, ad apicem vix incrassata (—3 μ). Pili (aut pilorum cicatrices) in utriculis vetustioribus unus ad aliquot (—9) per utriculum, in zona 135—185 μ infra apicem portati. Filamenta medullaria plerumque 27—41 μ diam. Gametangia non observata.

Thallus convoluted to conduplicate, adherent to flat coral slabs or enfolding stems of *Cymodocea* or pieces of dead coral, developing orbicular foliose isobilateral excrescences to 6 cm. broad, very soft. Utricles in large clusters, (90—) 100—190 (—275) μ diam., 510—1,050 μ long (measured from apex to point of origin on parent utricle), size proportional to order of branching; primary utricles 190—275 μ diam., to 1·5 mm. long; utricles of final order of branching often not developing medullary filaments; utricles cylindrical to slightly clavate, slightly constricted in region 100—130 μ below apex (just above hair scar zone); tips of apices rounded, with sides often flattened or depressed; utricular wall 1·5—2 μ thick, only slightly thickened at apex (—3 μ). Hairs (or hair scars) common on older utricles, one to several (—9) per utricle, borne in zone 135—185 μ below apex. Medullary filaments mostly 27—41 μ diam. Gametangia not observed.

Type.—Sandbank covered with coral debris off Ponta Rasa, Inhaca Channel, Mozambique, on *Cymodocea ciliata*, 25.ix.1957, leg. W. Macnae, comm. *Pocock 12268* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Other Collections Examined.—MOZAMBIQUE. Barreira Vermelha, on flat coral slabs near reef, 25.ix.1957, *Pocock 12260* (MAP). Cabo Inhaca, [on tufts of small corallines?] on floor of large pool in low tide terrace, in company with *C. acuminatum*, *C. lucasii* subsp. *capense*, *C. prostratum*, and *C. pocockiae*, 26.ix.1957, *Pocock 12283* (MAP). This species grows abundantly on *Cymodocea* and dead coral in Inhaca Channel. It is obviously closely related to *C. arabicum*, originally described from the Red Sea, from which it differs in having larger and stouter utricles with thin-walled apices of a characteristic shape: tips rounded, but often with the sides flattened or even depressed. The tendency toward asymmetrically flattened or depressed and slightly thickened apices (commonly to 6 μ, less often to 10 μ thick), exhibited by the type specimens of both *C. arabicum* and *C. coronatum* (cf. Silva 1952, fig. 11), is not present in *C. mozambiquense*. Previously (Silva 1952, p. 382) I have discussed the *C. arabicum* complex and described the spectrum of variation exhibited by specimens studied up to that time. Regarding

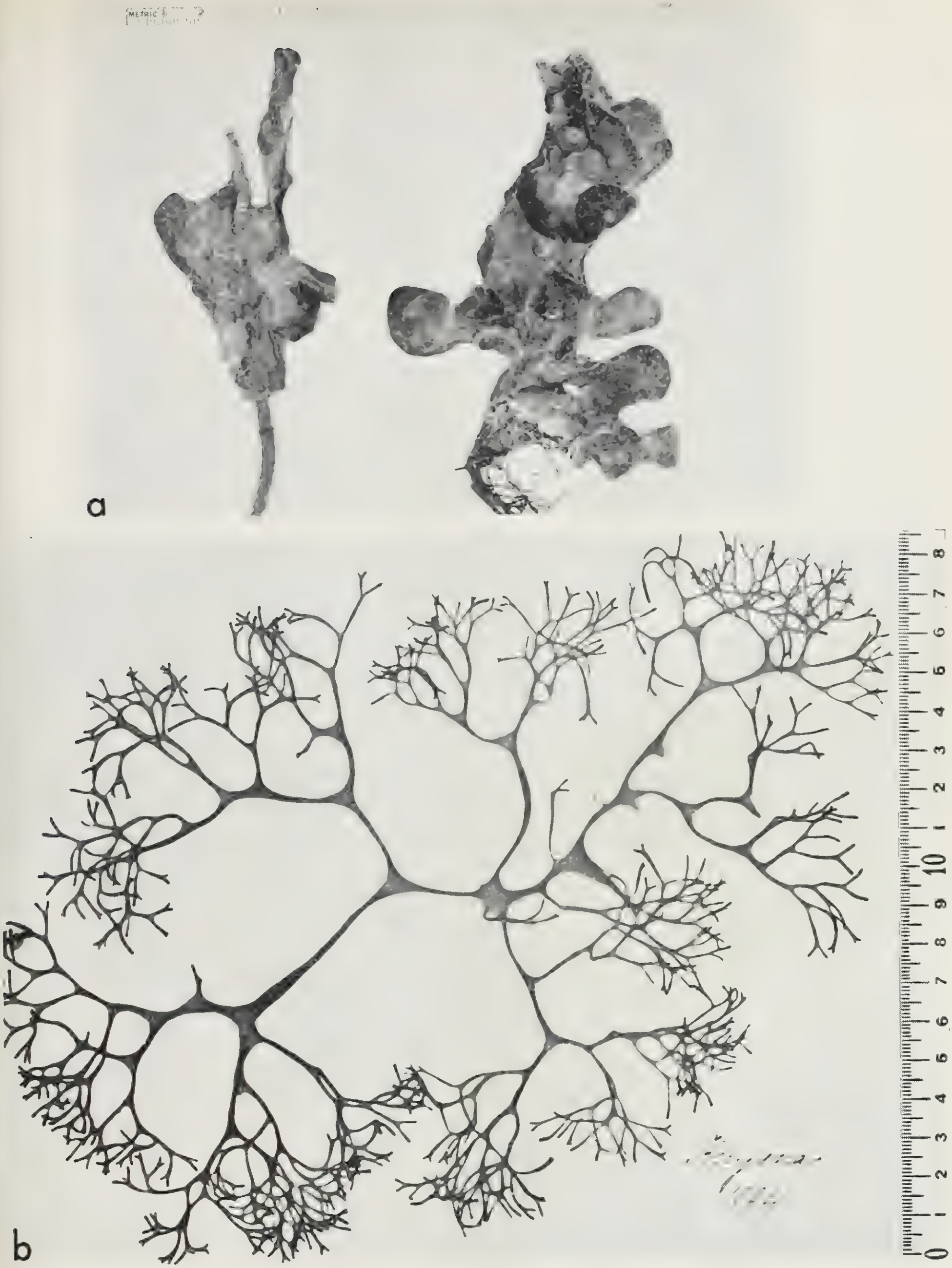

Plate II.

a, Codium mozambiquense (Ponta Rasa, Mozambique, *Pocock 12268*, part of type collection; left hand specimen = plant "C", an isotype; right hand specimen = plant "G", the holotype); *b, Codium tenue* (Knysna, C.P., *A. Weber-van Bosse*, L).

the present material, my first inclination was to consider it as representative of a distinctive subspecies of *C. arabicum.* The decision to propose a new species rests on the belief that this treatment may facilitate an analysis of the complex, with the realization, however, that future study of material from the East African coast between Lourenço Marques and the Red Sea may lessen the individuality of the present material.

3. **Codium lucasii** Setchell subsp. **capense** subsp. nov. [Fig. 3]

Previous South African Records.—Barton 1896, p. 194, as *C. adhaerens*, Knysna (*Newdigate*) record only, pro parte (identity inferred from description). Schmidt 1923, p. 27, as *C. adhaerens*, "Kaffernküste" record only (identity inferred from description and locality). Eyre, Broekhuysen,

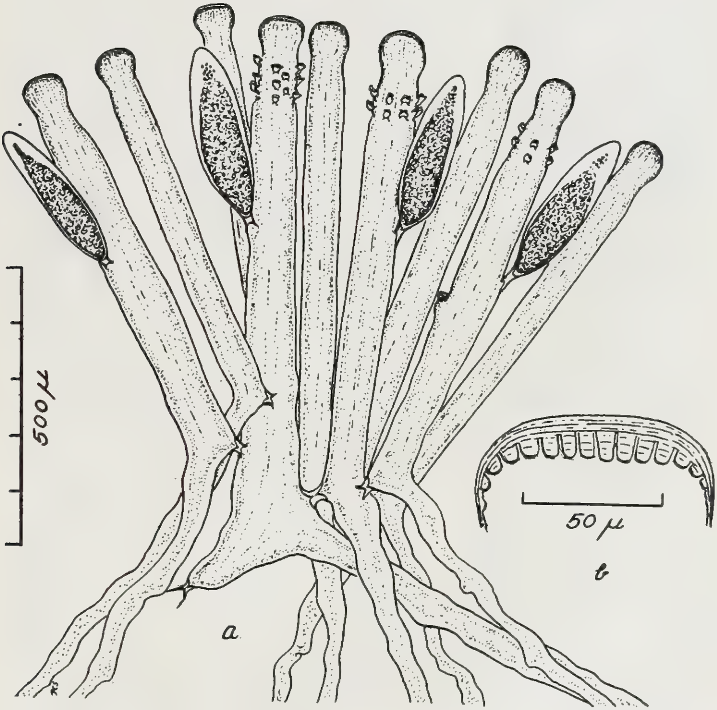

FIG. 3.—*C. lucasii* subsp. *capense*. *a* (Umpangazi, Natal, *Ecol. Surv. G.2.B*), mature group of utricles from centre of thallus; *b* (Storms River, C.P., *Ecol. Surv. TT.7.A*), apex of utricle showing details of wall thickening.

and Crichton 1938, p. 91, as *C. stephensiae* (*Ecol. Surv. L.15*). Stephenson 1944, pp. 314, 317, and 349, as *C. lucasii* (*Ecol. Surv. AR.1.D*; etc.). Stephenson 1947, pp. 284 and 296, as *C. lucasii.* Silva 1951, p. 92, fig. 15, as *Codium sp.* Pocock 1958, p. 25, as *C. arabicum* and *C. lucasii.*

Thallus applanatus solidus lubricus atroviridis, 2·5—5 mm. crass., primum orbicularis, mox lobos, marginibus non affixis, substrato arcte plane adhaerentes evolvens. (Thalli epiphytici conduplicati excrescentiis orbicularibus foliosis substratum implicantes.) Utriculi multum fastigiati (50—) 60—105 (—125) μ diam., (435—) 500—800 (—1,100) μ long. (ab apice ad locum originis in utriculo parenti metati), magnitudine ad ordinem ramificationis pro portione, cylindrici, 50—80 μ infra apicem mediocre ad valde constricti; apices truncati, depressi aut rotundati, quasi symmetrici; membrana utricularis tenuis (1·5 μ), ad apices plerumque vix aut paululum (3—12 μ), raro modice (—35 μ) incrassata, interne saepe non profunde alveolata ad profunde cribrosa; pili (aut pilorum cicatrices) in utriculis vetustioribus frequentes, in taeniam 70—145 μ infra utriculi apicem extendens portati, saepe ordines verticales formantes. Filamenta medullaria (15—) 20—35 μ diam. Gametangia lanceo-ovata, fusiformia ad oblanceo-ovata (48—) 60—125 μ diam., 215—370 μ long., unum per utriculum (duo in utriculis vetustioribus maioribusque) in pediculo distincto 280—405 μ infra apicem utriculi plerumque portata.

Thallus applanate, firm, slippery, very dark green, 2·5—5 mm. thick, at first orbicular, soon developing lobes which form a close flat pattern tightly adherent to substratum but with free margins. (Epiphytic thalli conduplicate, enfolding substratum, with orbicular foliose excrescences.) Utricles in large clusters, (50—) 60—105 (—125) μ diam., (435—) 500—800 (—1,100) μ long (measured from apex to point of origin on parent utricle), size proportional to order of branching, cylindrical, slightly to markedly constricted 50—80 μ below apex; apices truncate, depressed, or rounded, approximately symmetrical; utricular wall thin (1·5 μ), at apices usually very slightly or slightly thickened (3—12 μ), seldom moderately thickened (—35 μ), internally often shallowly alveolate to deeply cribrose; hairs (or hair scars) common on older utricles, borne in band extending 70—145 μ below apex of utricle, often forming vertical rows. Medullary filaments (15—) 20—35 μ diam. Gametangia lance-ovoid, fusiform, to oblance-ovoid, (48—) 60—125 μ diam., 215—370 μ long, usually borne one per utricle (two on older and larger utricles) on distinct pedicel 280—405 μ below apex of utricle.

Type.—Chaka's Rock (near Umhlali), Natal, 12.vii.1938, *Pocock & Papenfuss 1058* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Known Range.—Somerset Strand, False Bay (drift ?); Struis Bay Beach, Cape Province, to Cabo Inhaca, Mozambique.

Representative Collections Examined.—CAPE PROVINCE. Somerset Strand, drift ?, 2.xii.1937, *Papenfuss s.n.* Struis Bay Beach, cast ashore, 1.iii.1937, *Papenfuss 335.* Arniston, 23.xi.1939, *Ecol. Surv. AR.1.D.* Cape Infanta, 8.xii.1939, *Ecol. Surv. CI.1.E.* Still Bay, 10.xi.1939, *Ecol. Surv. SSS.1.G.* Groot River Mouth, ii.1941, *Rhodes Univ. Coll. Exped.* (RU). Knysna, 26.ix.1958, *Isaac B.693* (WEI). Storms River Mouth, 25.i.1940, *Ecol. Surv. TT.7.A.* Port Elizabeth, 1894, *Weber-van Bosse* (L, NY). Bushman's River Mouth, vii.1937, *Duthie 8388.* Kasouga (Ship Rock), 1.iii.1953, *Pocock 10589.* Sharks Bay, 21.ix.1952, *Pocock 10507.* Port Alfred, 1.vii.1938, *Pocock & Papenfuss 1052.* Riet River Mouth, 2.x.1943, *Pocock 7719.* Cove Rock, 18.vii.1943, *Pocock 7360.* East London (Shelly Beach), 6.vii.1937, *Ecol. Surv. L.15.* Qolora, 4.x.1952, *Pocock 10560.* Qora River Mouth, 3.viii.1938, *Pocock & Papenfuss 1044.* Dwessa, 16.i.1953, *Isaac I.1158.* Port St. Johns, 28.vii. 1938, *Pocock & Papenfuss 1048.* NATAL. Port Edward, 16.v.1939, *Ecol. Surv. WW.1K.* Port Shepstone, 27.vii.1938, *Pocock & Papenfuss 1047.* Hibberdene, 30.x.1951, *Pocock 9985.* Isipingo, 18.vii.1938, *Pocock & Papenfuss 1255* (UC only). Reunion Rocks, 29.x.1951, *Pocock 9943.* Durban (The Bluff), 15.vii.1938, *Pocock & Papenfuss 1051.* Umhloti Beach, 9.vii.1938, *Pocock & Papenfuss 1256.* Umpangazi, 2.v.1939, *Ecol. Surv. G.2.B.* Kosi Bay, 25.v.1948, *Rodin 4631.* MOZAMBIQUE. Cabo Inhaca, on floor of large pool in low tide terrace, 26.ix.1957, *Pocock 12289* (MAP). Sandbank covered with coral debris off Ponta Rasa, on *Cymodocea* and dead coral, 25.ix.1957, leg. W. Macnae, comm. *Pocock 12276.* Barreira Vermelha, on flat coral slabs near reef, 13.xii.1955, *Pocock 11089* (MAP).

The slightly larger diameter of utricles of *Codium lucasii* as represented in South Africa enables a South African specimen to be distinguished from an Australian specimen in a majority of instances. There is an overlap in the range of variation of the two subspecies, however, and certain South African plants (e.g., *Rodin 4631* from Kosi Bay) have utricles of an average diameter smaller than certain Australian plants (e.g., *Womersley A20,401* from Elliston).

From Arniston to Umpangazi, *C. lucasii* exhibits relatively little morphological variability. In the Inhaca region, however, considerable variability is displayed, both in habit (as related to habitat) and in anatomy. While *C. lucasii* is always saxicolous in the Union, in the Inhaca region it often grows on *Cymodocea* and corallines. Epiphytic thalli develop orbicular foliose isobilateral excrescences and thus resemble *C. mozambiquense* and other members of the *C. arabicum* complex. Anatomically, some plants, both saxicolous and epiphytic, closely resemble plants from the Union, while other plants have stouter utricles with apices less markedly or not at all cribrose, features suggestive of *C.*

mozambiquense. These plants, however, clearly seem more closely related to *C. lucasii* subsp. *capense* than to *C. mozambiquense* or to any other facet of the *C. arabicum* complex known to me. Further speculation as to their taxonomic disposition must await more detailed studies.

The earliest South African collection of this species apparently is one made by Mme. Weber-van Bosse in 1894 at Port Elizabeth and identified by her as *C. adhaerens.* Subsequently, Barton (1896) reported under the name *C. adhaerens* a collection from Knysna which, to judge from her description, was a mixture of *C. lucasii* and *C. stephensiae.* (I have not been able to locate this collection, which Barton indicated as liquid-preserved.) Barton's record was discussed by Dickinson (1932, p. 135) in connection with her account of *C. stephensiae.* Despite Miss Dickinson's statement that "it is practically certain that the entirely adhaerent specimens referred to by Miss Barton differ specifically [from *C. stephensiae*]," the presence of an entirely (or almost entirely) adherent *Codium* in South Africa was forgotten until Dr. Papenfuss, in connection with the Ecological Survey, pointed out differences in habit and habitat between *C. stephensiae* and the plants which he referred to *C. lucasii.* The thallus of *C. stephensiae* develops large lobes which are isobilateral (i.e., with cortex on both surfaces), prostrate, and mostly or entirely free from the substratum. The lobes of *C. lucasii* are small, dorsiventral (i.e., with cortex only on the upper surface), and firmly adherent to the substratum everywhere except at the margins. *C. stephensiae* usually grows in pools in the lower littoral zone of sheltered situations. *C. lucasii,* on the other hand, over most of its range forms a broad zone at mid-tide level which extends across fully exposed as well as partially protected areas. (At Inhaca it appears to be submerged even at low tide, whether it is epiphytic or saxicolous.) In earlier work of the Ecological Survey the two species were confused; in more recent work they have been properly separated. Setchell (in manuscript) considered the entirely adherent South African *Codium* distinct from *C. lucasii,* but his concept was based on a mixture of *C. lucasii* and *C. pelliculare.*

C. lucasii is readily distinguishable from *C. stephensiae* anatomically. The thallus dissects out into irregularly sized clusters of utricles without particularly conspicuous primary utricles. The utricles are characteristically capitulate, and the apices are often internally shallowly alveolate to deeply cribrose. In *C. stephensiae,* by contrast, the thallus dissects out into large clusters of utricles, each cluster comprising a conspicuously large primary utricle surrounded by derivative utricles whose size is proportional to the order of branching. The utricles are characteristically constricted below the apex for a distance of about 100 μ, giving a pronounced ninepin appearance. The apices are usually moderately thickened and broadly introrsely umbonate, but rarely alveolate or cribrose.

4. **Codium stephensiae** Dickinson, Rev. Alg. 6: 131, pl. 3, text—figs. 1—3 (1932). Isaac 1937*b*, p. 130. Stephenson, Stephenson, and Du Toit 1937, pp. 356, 367, and 372. Stephenson, Stephenson, and Bright 1938, p. 6. Eyre 1939, p. 296. Pocock 1939, p. 78. Stephenson 1944, pp. 314, 317, 336, and 350. Stephenson 1947, pp. 284 and 296. Isaac 1949, pp. 132, 140, 150, 155, 156, 157, and 158. [Fig. 4, Plates III and IV]

Records Under Incorrect Determinations.—Barton 1893, p. 82, as *C. laminarioides* (Cape Point, *Boodle*, BM). Barton 1896, p. 194, as *C. adhaerens*, Knysna (*Newdigate*), pro parte (identity inferred from description); Port Elizabeth (*Farquhar 7*, 1893, BM). Delf 1921, p. 58,

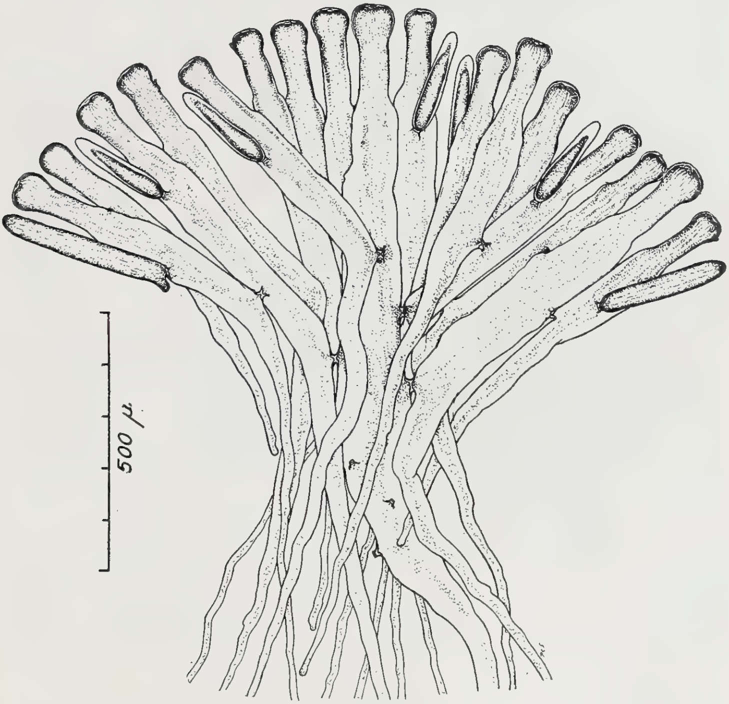

Fig. 4.—*C. stephensiae* (Storms River, C.P., *Ecol. Surv. T.2.C*). Mature group of utricles from centre of thallus.

as *C. lindenbergii* (identity inferred from locality). Delf and Michell 1921, p. 95, as *C. lindenbergii*, False Bay record only (Gordons Bay, *W. Tyson*, BOL).

Excluded Record.—Eyre, Broekhuysen, and Crichton 1938, p. 91= *C. lucasii* subsp. *capense* (*Ecol. Surv. L.15*).

Thallus applanate, procumbent, velvety but tough, dark green, 2·5—4 mm. thick, adherent to substratum in central portion and here and there in otherwise free lobes by patches of rhizoidal attachments; lobes crenate when young, becoming irregularly or subdichotomously cleft, isobilateral, in large part free from substratum, anastomosing one with another, to 30 cm. long. Utricles of dorsal surface in large clusters, varying in length from 315 μ (ultimate order of branching) to 1·5 mm. (first order of branching), mostly 55—110 (—125) μ diam. at apex, cylindrical, with slightly rounded to truncate or depressed apices, usually constricted below apex for distance of 80—115 μ, giving a ninepin effect, expanding to maximum diameter below constriction; utricular wall 1·5—3 μ thick, at apices moderately thickened (—30 μ) and lamellate, slightly to markedly broadly introrsely umbonate with a tendency to be extrorsely umbonate as well. Utricles of ventral surface similar to those of dorsal surface, but usually stouter and less characteristically constricted. Hairs (or hair scars) scarce, 1 (—3) per utricle, borne 35—50μ below apex. Medullary filaments mostly 19—52 μ diam., one arising from base of each utricle by stout outgrowth so that utricle and filament intergrade. Gametangia cylindrical, 45—75 μ diam., 200—325 μ long, one (seldom two) per utricle, borne on short pedicel 300—460 μ below apex of utricle.

Type.—Not designated, but inasmuch as the original description was "largely based on material collected by Mr. G. Taylor of the British Museum and preserved in formalin" (Dickinson 1932, p. 135), the Taylor specimen from Kommetje, a photograph of which was published as pl. 3, fig. A, and which is now dried and conserved in the herbarium at Kew, is hereby selected as lectotype.

Known Range.—Cape Province: Langebaan to Dwessa.

Representative Collections Examined.—CAPE PROVINCE. Langebaan, 3.iii.1938, *Papenfuss 331.* Melkbosch, 5.ii.1939, *Papenfuss 382.* Kommetje, 1927, *G. Taylor* (K). Olifantsbosch, 4.iv.1954, *Isaac I.462.* Cape Maclear, 10.i.1947, *Pocock 8992.* False Bay: Kalk Bay, 20.vii.1936, *Papenfuss 333*; Strandfontein, xii.1932, *E. L. Stephens*; Somerset Strand, 23.iv.1935, *A. V. Duthie*; Gordons Bay, *W. Tyson* (BOL); Steenbras River Mouth, 21.iii.1936, *G. van Wyk*; Cape Hangklip, 8.i.1940, *Ecol. Surv. C.H.1.B.*; *CH.4.A.* Hermanus, 2.vii.1939, *Ecol. Surv. HM.5.A.* Danger Point, 27.xi.1939, *Ecol. Surv. D.D.P.1.B.* Cape Agulhas, 22.ii.1939, *Pocock 497.*

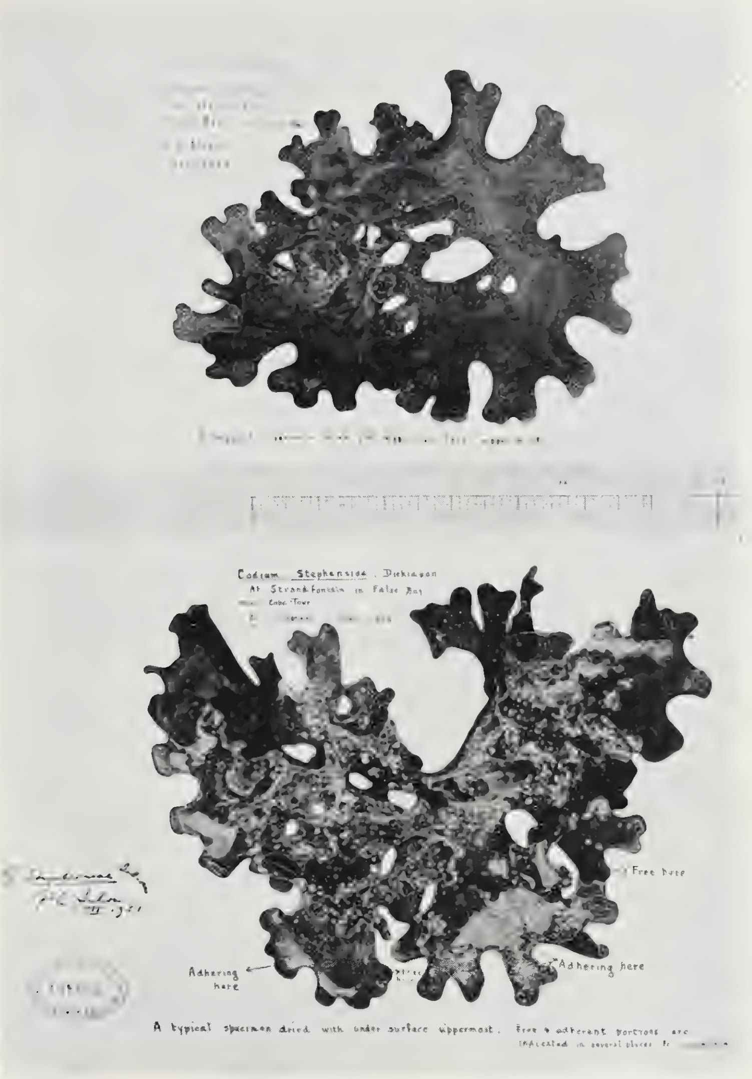
Codium Stephensiae, Dickinson
At Strandfontein in False Bay
Cape Town
Free here
Adhering here
Adhering here
A typical specimen dried with under surface uppermost. Free & adherent portions are indicated in several places

Plate III. *Codium stephensiae.*
(Strandfontein, False Bay, C.P., *E. L. Stephens.*)

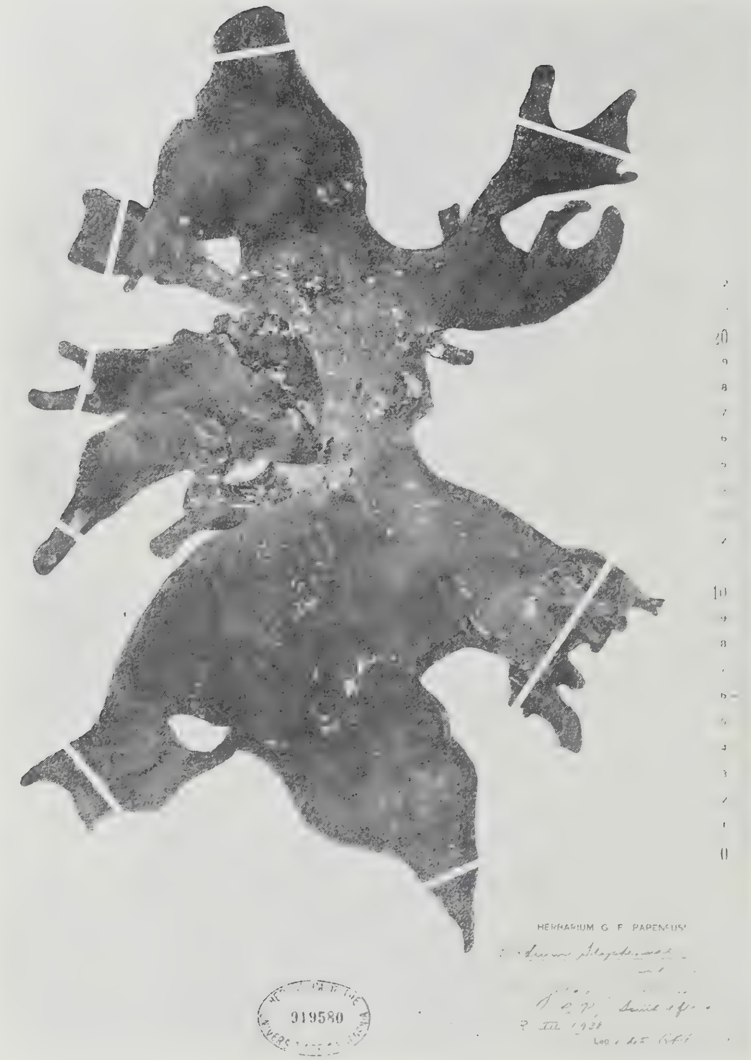

PLATE IV. *Codium stephensiae.*
(Langebaan, C.P., *Papenfuss 331*). An unusually large plant.

Arniston, 20.ii.1939, *Pocock 524A*. Groot River Mouth, ii.1941, *Rhodes Univ. Coll. Exped.* (RU). Storms River Mouth, 2.iv.1939, *Ecol. Surv. T.2.C*; 24.i.1940, *Ecol. Surv. TT.2.A*. Humewood, 1.i.1937, *W.J.G. Styn.* Port Elizabeth, 13.ii.1952, *Isaac B.465.* Port Alfred, 21.i.1939, *Ecol. Surv. K.3.B.* Riet River Mouth, 2.x.1943, *Pocock 7718.* Kleinmond, 19.iii.1939, *Ecol. Surv. X.1.U.* Kidd's Beach, 2.v.1957, *Isaac B.516* (WEI). East London, 20.vi.1948, *Rodin 4778.* Morgan Bay, 2.vii.1943, *Pocock 7065.* Qolora, 20.v.1939, *Ecol. Surv. QQ.1.A.* Dwessa, 14.i.1953, *Isaac B.466.*

The earliest collection of *C. stephensiae* of which I am aware is one made by Burmann (PC) and designated by Lamouroux on the herbarium label as a new species (which was never published). The earliest record of *C. stephensiae* is the report by Barton (1893) under the name *C. laminarioides* of a specimen collected at Cape Point by Boodle. Subsequently, collections of *C. stephensiae* intermixed with *C. lucasii* subsp. *capense* from Knysna and Port Elizabeth were reported by Barton (1896) under the name *C. adhaerens.* Barton's statement, "The specimens of this alga, which have been sent by Miss Newdigate, preserved in spirit, are only attached to the substratum at the centre of the thallus, and the rest of the flat frond is free, though prostrate," constitutes the first recognizable reference to *C. stephensiae.* Barton continued: "It was suggested to me that this was a new species of *Codium,* but since in the same sending I find plants in which the thallus entirely adheres to the substratum [*C. lucasii*], I believe that all the specimens are but forms of *C. adhaerens.*"

In its development of isobilateral lobes, *C. stephensiae* is set apart from all other adherent *Codium* except its close relative, *C. coarctatum* Okamura from Japan, which differs in its narrow, markedly subdichotomously cleft lobes and in certain details of its utricles. The lobes are isobilateral only in the sense that there is a ventral as well as a dorsal cortex of utricles. The ventral cortex is not as tightly packed as the dorsal cortex, however, and the utricles exhibit many differences: they contain less chlorophyll, they are stouter, their constriction is less uniformly characteristic, and they are intermixed with many single (unbranched) utricles. However, Miss Dickinson's statement that "as a rule the individual utricles are produced singly at the ends of the medullary filaments, but branching occurs to some extent" is not borne out by my observations. Toward the centre of the thallus the ventral utricles may be large, clavate, and thin-walled, of the type shown in fig. 2 of Miss Dickinson's paper. This type of utricle is common in all adherent *Codium* occurring near and on the margins, intermixed with "normal" (i.e., characteristic) utricles, and intermittently among the mass of rhizoids on the lower surface of the thallus.

C. stephensiae usually grows in pools in the lower littoral zone. According to Isaac (1949, p. 140), in the Rooi Els–Gansbaai region it "occurs typically in sheltered situations on vertical rock faces, and it seems to be favoured by the proximity of brackish water." Most localities where *C. stephensiae* grows luxuriantly, however, are not influenced by brackish water. According to Miss Pocock (in lit.), at Papenkuil Fontein near Cape Agulhas it carpeted a small rocky bay (8.ii.1940, *Pocock* 2850).

5. **Codium incognitum** sp. nov. [Fig. 5]

Thallus applanatus mollis ad 5 mm. crass., substrato per superficiam latam adhaerens. Utriculi fastigiati 100—165 (—260) μ diam., 720 μ—2·4 mm. long. (ab apice ad locum originis in utriculo parenti metati), magnitudine ad ordinem ramificationis pro portione, cylindrici, 575—850 μ infra apicem plerumque inflati; apices truncati aut paululum rotundati; membrana utricularis 1·5 μ crass., ad apices vix incrassata (—8 μ). Pili aut pilorum cicatrices non observati. Filamenta medullaria plerumque 25—55 μ diam., gametangia cylindrica ad paululum fusiformia, 55—75 μ diam., (210—) 260—340 (—390) μ long., 1—3 per utriculum, omnia in pediculis parvis (5—7 μ long.) 300—470 μ infra apicem portata.

Thallus applanate, soft, to 5 mm. thick, adherent to substratum over broad area. Utricles in clusters, 110—165 (—260) μ diam., 720 μ—2·4 mm. long (measured from apex to point of origin on parent utricle), size proportional to order of branching, cylindrical, frequently swollen 575—850 μ below apex; apices truncate or slightly rounded; utricular wall 1·5 μ thick, at apices only slightly thickened (—8 μ). Hairs or hair scars not observed. Medullary filaments mostly 25—55 μ diam. Gametangia cylindrical to slightly fusiform, 55—75 μ diam., (210—) 260—340 (—390) μ long, 1—3 per utricle, each borne on short pedicel (5—7 μ long) 300—470 μ below apex of utricle.

Type.—Robberg, Cape Province, 4.vi.1939, *Ecol. Surv. RR.1.F* (UC; isotype in CT).

While in general it is poor taxonomic practice to propose a new species on the basis of a single collection, the present material is so distinctive as to warrant its description. Only two fragments of plants are available, both male. The absence of hairs tentatively is significant. The closest relative in South Africa is *C. spongiosum*. A clear indication of the tidal zone which *C. incognitum* occupies is given by the fact that the thallus is attached to *Balanus* shells.

6. **Codium spongiosum** Harvey, Trans. Roy. Irish Acad. 22: 565 (1855). Stephenson 1947, p. 296, excl. Port Edward record. Pocock 1958, p. 25, as *Codium* sp. [Fig. 6]

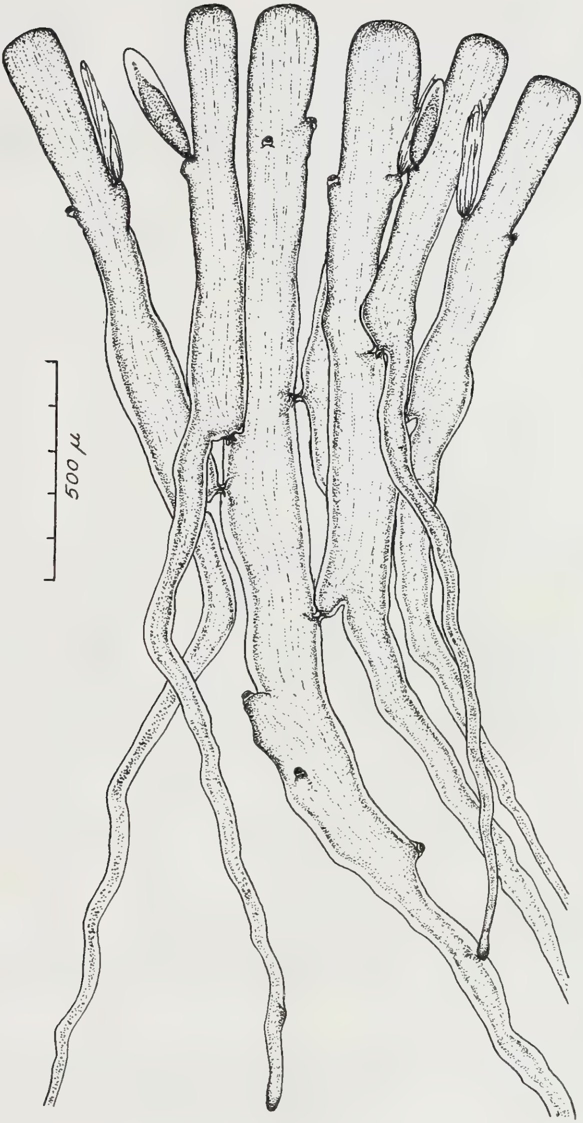

FIG. 5.—*C. incognitum* (Robberg, C.P., *Ecol. Surv. RR.1.F*=type). Mature group of utricles from centre of thallus.

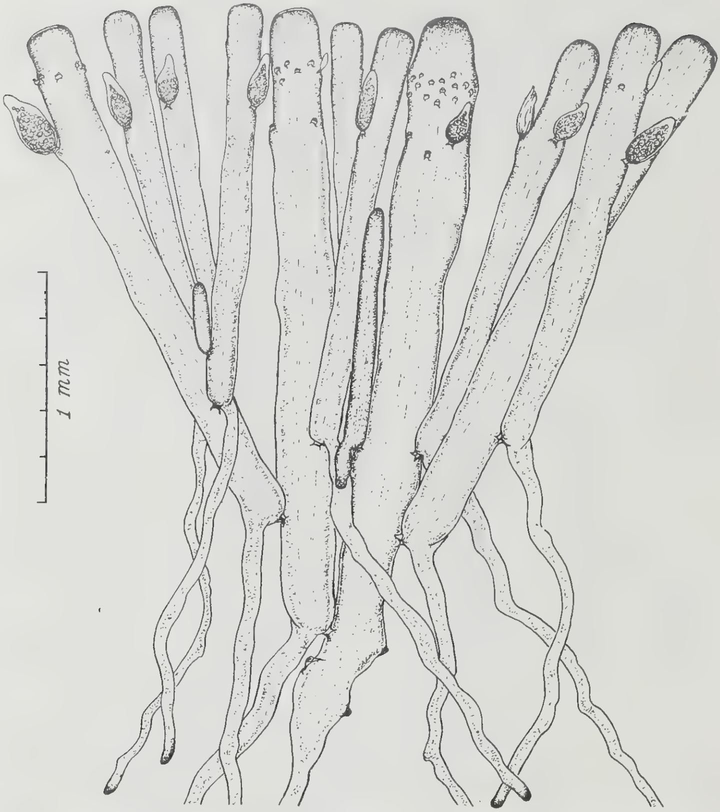

Fig. 6.—*C. spongiosum* (Durban, Natal, *Pocock & Papenfuss 372*). Mature group of utricles from centre of thallus.

Record Under Incorrect Determination.—Levring 1938, p. 16, as *C. mamillosum* (Isipingo, *Ecol. Surv. D. 23*, CT).

Excluded Records.—Schmidt 1923, p. 32=*C. bursa* (HBG, "C. b. sp." in error). Stephenson 1947, p. 296, Port Edward record only=*C. papenfussii* (*Ecol. Surv. WW.2.G*).

Thallus applanate or pulvinate, undulate to cerebriform, soft, becoming gelatinous in liquid preservative, nitidous when dried and pressed, to 2 cm. thick, 6—10 (—25) cm. diam., loosely adherent to substratum. Utricles in large clusters, those of final order of branching cylindrical or clavate, 130—300 (—390) μ diam., 1·4—2 mm. long, those of lower orders of branching to 520 μ diam. at apex, gradually enlarging below up to 850 μ diam., 2·8—4 (—6) mm. long; apices subtruncate to rounded; utricular wall 2—3 μ thick, at apices very slightly to moderately thickened (—32 μ), incrassate apices finely lamellate and slightly introrsely umbonate. Hairs (or hair scars) abundant, forming band about 120—200 μ wide and 130—430 μ below apex of utricle. Medullary filaments mostly 30—100 μ diam. Gametangia lance-ovoid or ampulliform, 50—175 μ diam., 215—360 μ long, usually several per utricle, each borne on short pedicel 360—660 μ below apex of utricle.

Lectotype.—King George's Sound, Western Australia, *W. H. Harvey*, Algae Australicae Exsiccatae 577 (TCD).

Known Range.—Hibberdene, Natal, to Cabo Inhaca, Mozambique. Mauritius. Australia. Lord Howe Island. New Caledonia. Hawaiian Islands.

Representative South African Collections Examined.—NATAL. Hibberdene, 30.x.1951, *Pocock 9982.* Umtwalumi River Mouth, 25.xii.1938, *Ecol. Surv. M.1.A.* Isipingo Beach, xi.1894, *Weber-van Bosse* (L); 28.vi.1935, *Ecol. Surv. D.23* (CT). Reunion Rocks, 29.x.1951, *Pocock 9942.* Durban (The Bluff), 15.vii.1938, *Pocock & Papenfuss 372.* Umhlali Beach (Chaka's Rock), 23.xii.1938, *Ecol. Surv. U.21.A* (CT). Kosi Bay, 25.v.1948, *R. J. Rodin.* MOZAMBIQUE. Cabo Inhaca, cast ashore, 26.ix.1957, *Pocock 12292* (MAP).

The only record of *C. spongiosum* from South Africa other than Stephenson's (1947) is that by Schmidt (1923, p. 32), who cited only "Kap". Lucas (1935, p. 202) conjectured that "Kap" might refer to Cape York, and Børgesen (1946, p. 46) accepted this interpretation. Fortunately, I have located the specimen upon which the record is based in Herb. Hamburg. It bears the datum, "Cap. b. sp.," and is annotated *C. spongiosum* by Schmidt. This specimen is referable to *C. bursa*, and it is reasonable to conclude that it did not come from South Africa. Mme. Weber-van Bosse collected *C. spongiosum* at Isipingo in 1894 and determined it as *C. adhaerens*, but this was not recorded in literature.

Anatomically, the South African material is indistinguishable from plants from Western Australia, the type locality. South African plants exhibit some differences in habit and habitat, however: they apparently never attain the great size of Australian plants; and they are uncommon, growing in cracks in flat open bare rock or around the rims of small pools in the lower littoral zone, whereas in Australia this is a very abundant sublittoral species, extending to just below low tide level.

C. spongiosum is the only strictly Indo-Pacific element in the South African *Codium* flora.

7. **Codium papenfussii** sp. nov. [Fig. 7, Plate V]

Records Under Incorrect Determinations.—Delf and Michell 1921, p. 95, as *C. bursa*, Camps Bay record only (identity inferred from description and locality). Pocock 1939, pp. 76 and 78, as *C. bursa.* Stephenson 1947, p. 296, as *C. spongiosum*, Port Edward record only (*Ecol. Surv. WW.2.G*).

Thallus iuvenis hemisphericus ad subglobosum solidus, vetustior per attenuationem plexus filamentorum medullarium ad 7 (—12) mm. diam. applanatus cavusque, subtrato per penicillum hapterorum rhizoideorum laxe adhaerens, in latere inferiore depressus. Utriculi maturi parum fastigiati, cylindrici aut paululum clavati, gibberum prominentem 350—700 μ infra apicem proprie praebentes, (300—) 330—520 μ diam. in apice, ad 680 μ ad gibbum (2·4—) 3—4·6 (—5·4) mm. long.; apices truncati aut paululum rotundati; membrana utricularis 2·5—5 μ crassa ad apices aliquantulum incrassata (—12 μ). Pili absentes. Filamenta medullaria plerumque 50—110 μ diam., unum per excrescentiam crassam a basi utriculi omnis enascens. Gametangia lanceo-ovata, 155—220 μ diam., 480—590 μ long., in pediculis circa 15 μ long., uno vel duobus per utriculum, 920—1,050 μ infra utriculi apicem portata.

Thallus when young hemispherical to subglobose, firm, becoming flattened and hollow with age by attenuation of plexus of medullary filaments, to 7 (—12) cm. diam., loosely adherent to substratum by tuft of rhizoidal holdfasts, depressed on under side. Mature utricles in small clusters, cylindrical or slightly clavate, characteristically with a prominent bulge 350—700 μ below apex, (300—) 330—520 μ diam. at apex, to 680 μ diam. at bulge, (2·4—) 3—4·6 (—5·4) mm. long; apices truncate or slightly rounded; utricular wall 2·5—5 μ thick, at apices slightly thickened (—12 μ). Hairs absent. Medullary filaments mostly 50—110 μ diam., one arising from base of each utricle by stout outgrowth. Gametangia lance-ovoid, 155—220 μ diam., 480—590 μ long, borne on pedicel about 15 μ long, one or two per utricle, 920—1,050 μ below apex of utricle.

Type.—Kalk Bay (in False Bay), Cape Province, cast ashore, 14.xi.1936, *Papenfuss 327* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Known Range.—Camps Bay, Cape Province, to Port Edward, Natal.

Representative Collections Examined.—CAPE PROVINCE. Kommetje, viii.1927, *A. V. Duthie.* False Bay: Muizenberg, 30.xii.1945, *M. A. Pocock 8577*; Somerset Strand, 14.iv.1933, *E. Strauss*; Gordons Bay, *Duthie 8091.* Struis Bay Beach, 1.iii.1937, *Papenfuss 328.* Arniston, 13.xii.1942, *Pocock 6607.* Still Bay, iv.1937, *N. van der Merwe.* Port

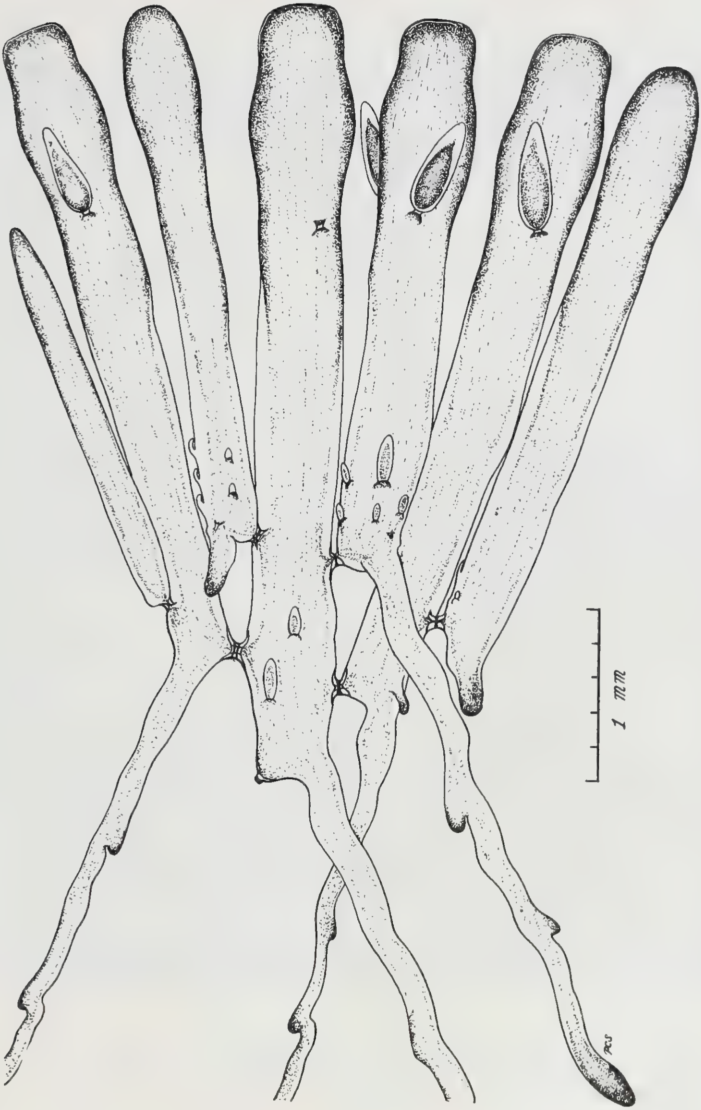

FIG. 7.—*C. papenfussii* (Port Edward, Natal, *Ecol. Surv. WW.2.G*). Mature group of utricles.

Elizabeth, 11.ii.1952, *Isaac B.480* (WEI). Quaai Hoek, Richmond, 13.ii.1944, *Pocock 8027*. Riet River Mouth (Three Sisters), 14.viii.1946. *Pocock 8775*. NATAL. Port Edward, 17.v.1939, *Ecol. Surv. WW.2.G.*

The earliest record of *C. papenfussii* is the report by Delf and Michell of "*C. Bursa* being washed up at Camps Bay after rough weather." Numerous dried specimens, mostly from False Bay, were sent by Dr. A. V. Duthie to Professor Setchell, who (in herbarium notes) considered them representative of a new species, but he confused this entity with *C. megalophysum*. Working with living or liquid-preserved material, one can easily distinguish among *C. papenfussii*, *C. megalophysum*, and *C. bursa*. *C. megalophysum* is distinguished from all other species by its huge utricles (1—3·9 mm. diam.), loosely grouped in a hemispherical or subglobose cluster. *C. bursa*, though not very different in habit from *C. papenfussii*, exhibits fundamental anatomical differences. In *C. bursa* the thallus dissects out mostly into individual utricles; occasional clusters of two or three utricles result from foreshortening and abortion of secondary sympodial systems. In *C. papenfussii* the thallus dissects out into small clusters of utricles. From the base of each secondary utricle there arises by a stout outgrowth a medullary filament, which usually ends blindly in the medulla but which may grow back into the cortex and enlarge into a primary utricle. In addition to these fundamental differences, the utricles of *C. papenfussii* are on the average of greater diameter and length than those of *C. bursa*, exhibit a prominent bulge 350—700 μ below the apex, and have apices with a thin or only slightly thickened wall; those of *C. bursa* lack the bulge and frequently have very thick and conspicuously lamellate apical walls. Hairs (or hair scars), which are common in *C. bursa*, are lacking in *C. papenfussii*.

The majority of specimens at hand have been collected in the drift, indicating that this species inhabits off-shore reefs in deep water. According to Miss Pocock (in lit.), it is occasionally found attached under overhanging ledges (Riet River) or in narrow clefts sheltered from direct sunlight (Port Elizabeth: Lighthouse Beach). Miss Duthie also found it attached at Somerset Strand. After storms it may be abundant in the drift (False Bay and Port Elizabeth). Attached intertidal plants are small, firm, and globular compared to the large, flattened, hollow plants usual in the drift.

It is a privilege to name this distinctive species after Professor Papenfuss, in recognition of his many contributions to our knowledge of South African seaweeds and in appreciation of the unlimited patience and enthusiasm with which he guided me through my doctoral programme.

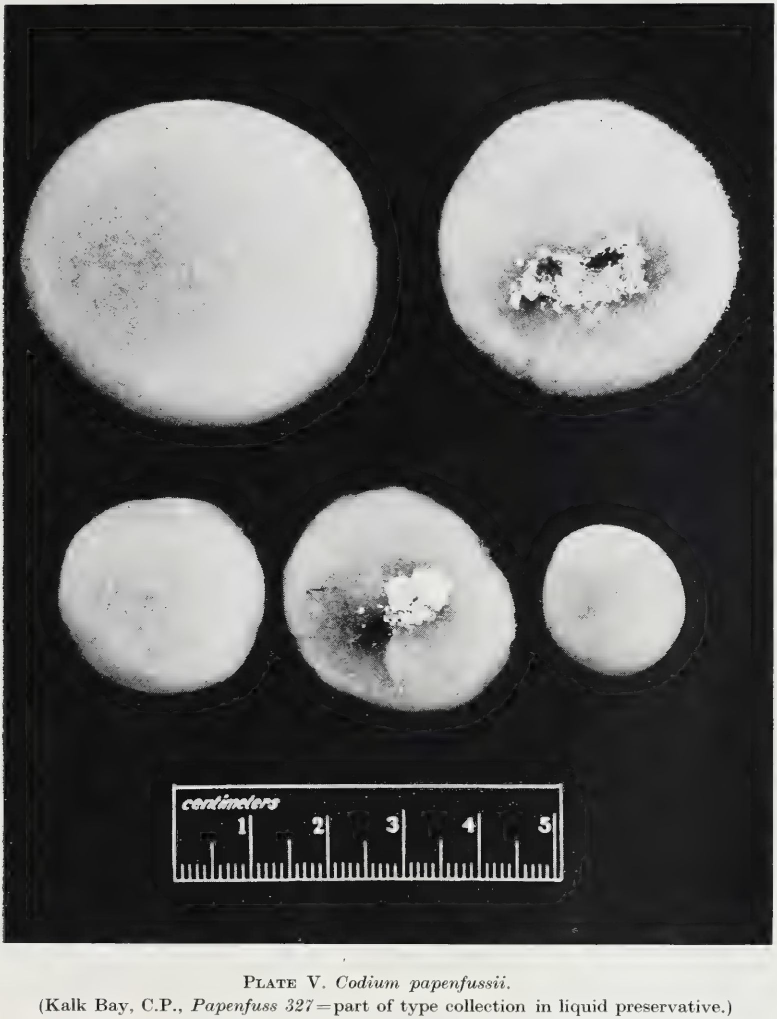

PLATE V. *Codium papenfussii.*
(Kalk Bay, C.P., *Papenfuss 327* = part of type collection in liquid preservative.)

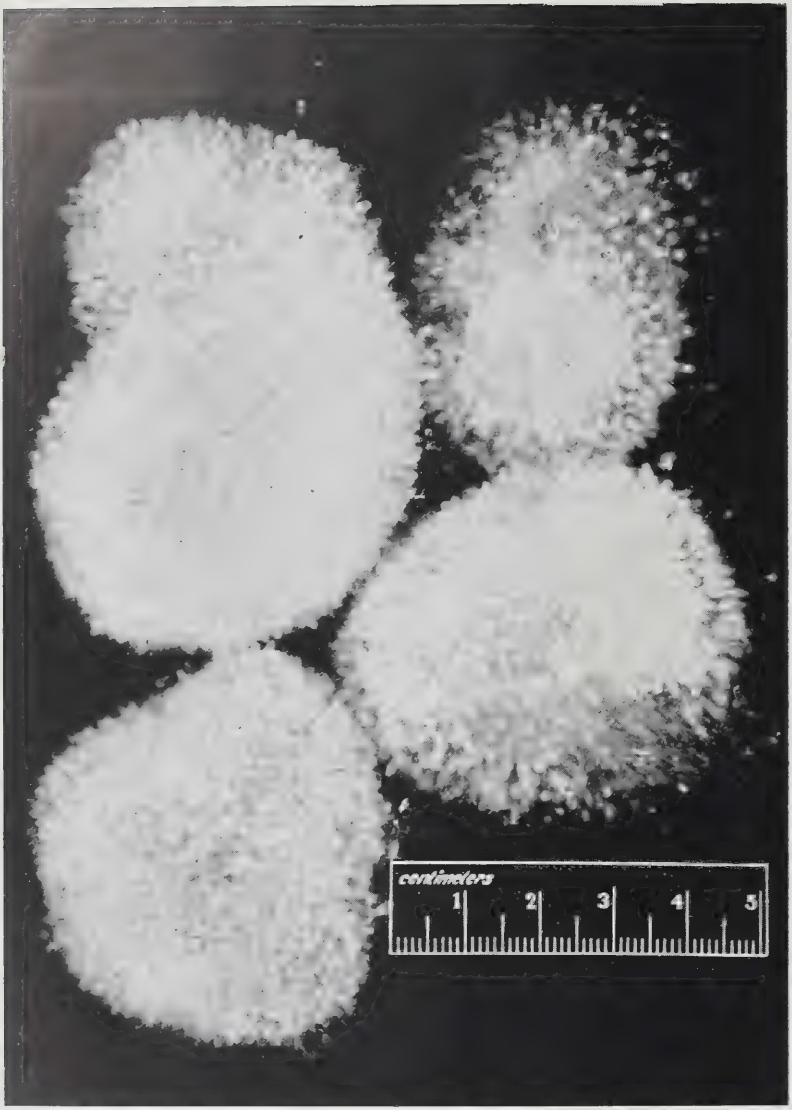

PLATE VI. *Codium megalophysum.*
(Port St. Johns, C.P., *Pocock & Papenfuss 324*=type.)

8. **Codium megalophysum** sp. nov. [Fig. 8, Plate VI]

C. mamillosum Harvey var. *capense* O. C. Schmidt, Bibl. Bot. 23 (91): 37 (1923). (Type=mouth of Illovo River, Natal, xi.1894, *A. Weber-van Bosse*, B, destroyed by fire March 1, 1943; isotypes in L, NY, UC.)

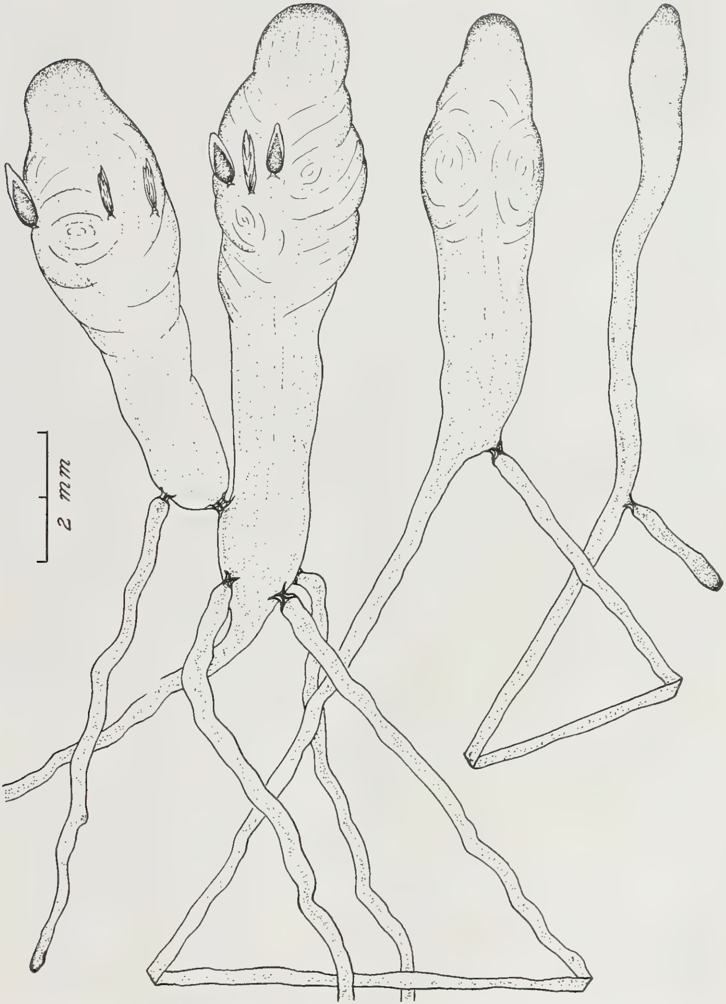

FIG. 8.—*C. megalophysum* (Port St. Johns, C.P., *Pocock & Papenfuss 324*=type). Mature group of utricles.

Records Under Incorrect Determinations.—Barton 1896, p. 459, as *C. mamillosum* (Illovo, *Weber-van Bosse*, L, NY, UC). Levring 1938, p. 6, as *Valonia aegagropila* (Isipingo, *Ecol. Surv. D. 68*, CT). Stephenson 1947, pp. 284 and 296, as *C. mamillosum*, pro parte (Port Edward, *Ecol. Surv. W.6.B*).

Thallus hemisphericus aut globosus laxissimus dilute viridis ad 9·5 cm. diam., substrato per penicillum hapterorum rhizoideorum laxe adhaerens. Utriculi per amplificationem ramorum systematis sympodialis formati; systemata sympodialia secondaria plerumque ita reducta ut utriculi in utriculos parentes directe protentur; utriculi maturi clavati, evaginationibus nodiformibus aut mammiformibus dimidia in superiore praediti, (1—) 1·5—2·7 (—3·9) mm. diam., 5—12 mm. long.; apices rotundati, membrana utricularis relative tenuis (4·5 μ) in apice paululum incrassata (—13 μ). Filamenta medullaria plerumque 215—430 μ diam., pili aut pilorum cicatrices non observati. Gametangia ellipsoidea ovata aut ampulliformia, 190—380 μ diam., 540—1,030 μ long., in pediculis relative brevibus (12—24 μ) portata, aliquot per utriculum, 2—3·5 mm. infra utriculi apicem.

Thallus hemispherical or globose, very loose, light green, to 9·5 cm. diam., loosely adherent to substratum by tuft of rhizoidal holdfasts. Utricles formed by enlargement of branches of a sympodial system; secondary sympodial systems often reduced to the degree that utricles are borne directly on parent utricles; mature utricles clavate, with knobby or mammiform evaginations in upper half, (1—) 1·5—2·7 (—3·9) mm. diam., 5—12 mm. long; apices rounded; utricular wall relatively thin (4·5 μ), slightly thickened at apex (—13 μ). Medullary filaments mostly 215—430 μ diam., hairs or hair scars not observed. Gametangia ellipsoidal, ovoid, or ampulliform, 190—380 μ diam., 540—1,030 μ long, borne on relatively short pedicel (12—24 μ long), several per utricle, 2—3·5 mm. below apex of utricle.

Type.—Port St. Johns, Cape Province, 30.vii.1938, *Pocock & Papenfuss 324* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Known Range.—Port Elizabeth, Cape Province, to Isipingo, Natal.

Representative Collections Examined.—CAPE PROVINCE. Port Elizabeth, drift, 5.xii.1933, *F. Holland* (RU). Amsterdam Hoek (Zwartkops River), 1941, *N. Bryant* (RU). East London (Bats Cave Rocks), 12.vii.1937, *Papenfuss 326*. Dwessa, *H. Rayment* (RU). Port St. Johns, 28.vii.1938, *Pocock & Papenfuss 325*. NATAL. Port Edward, 31.xii.1938, *Ecol. Surv. W.6.B.* Illovo River Mouth, xi.1894, *Weber-van Bosse* (L, NY, UC). Isipingo, 15.vii.1936, *Ecol. Surv. D.68* (CT).

Barton (1896) was the first to record this species, reporting a collection by Mme. Weber-van Bosse from the mouth of the Illovo River under the name *C. mamillosum.* Schmidt considered the difference in size of the utricles to be of varietal value, and proposed the variety *capense* for the South African plant. Setchell (in manuscript), dealing only with dried specimens, recognized the specific distinctness of the Weber-van Bosse material, but confused this entity with *C. papenfussii.* Levring referred juvenile plants of this species to *Valonia aegagropila.* With ample liquid-preserved material at hand, it is now possible to give an adequate description of this striking plant, one of the most spectacular members of the genus. Its huge utricles (to 3·9 μ diam.) have nearly twice the dimensions of those of *C. mamillosum*, and the gametangia can easily be seen with the naked eye.

On anatomical grounds it must be concluded that *C. megalophysum* is not at all closely related to *C. mamillosum*, but rather has as its nearest relative *C. bursa.* Like *C. bursa*, all utricles are produced by enlargement of branches of sympodial systems and the secondary sympodial systems (i.e., those arising secondarily from mature utricles) may be reduced to the degree that utricles are borne directly on parent utricles (i.e., pairs and triplets of utricles are formed), frequently in *C. megalophysum*, occasionally in *C. bursa.* Each mature utricle may produce a few secondary sympodial systems, most of which are abortive (i.e., they consist of a filament which ends blindly in the medulla). In *C. mamillosum*, by contrast, primary utricles produce secondary or branch utricles by budding from the lower half of the utricle, forming small clusters of utricles. Each derivative utricle develops several very slender filaments which end blindly in the medulla. These filaments are fundamentally different from those in *C. megalophysum* and *C. bursa*, which represent abortive sympodial systems, and unlike those filaments are not plugged at the point of origin (cf. Silva and Womersley 1956, fig. 6).

That *C. megalophysum* is primarily a deep water species, at least in the south-western part of its range, is indicated by the abundance of large thalli cast ashore in the Port Elizabeth region under certain conditions of wind and sea. At other localities it grows in the lower littoral zone in recesses or deep potholes where the thalli are protected from sun and surf. Intertidal plants are on the average smaller than those cast ashore.

9. **Codium pelliculare** sp. nov. [Fig. 9, Plate VII]

C. depressum Papenfuss, Ann. Natal Mus. 11: 284, 296. 1947. *Nomen nudum.*

Thallus applanatus membraniformis tenuis (1·5—3 mm.) solidus rotundatus, marginibus integris aut lobis late rotundatis praeditus, vetus

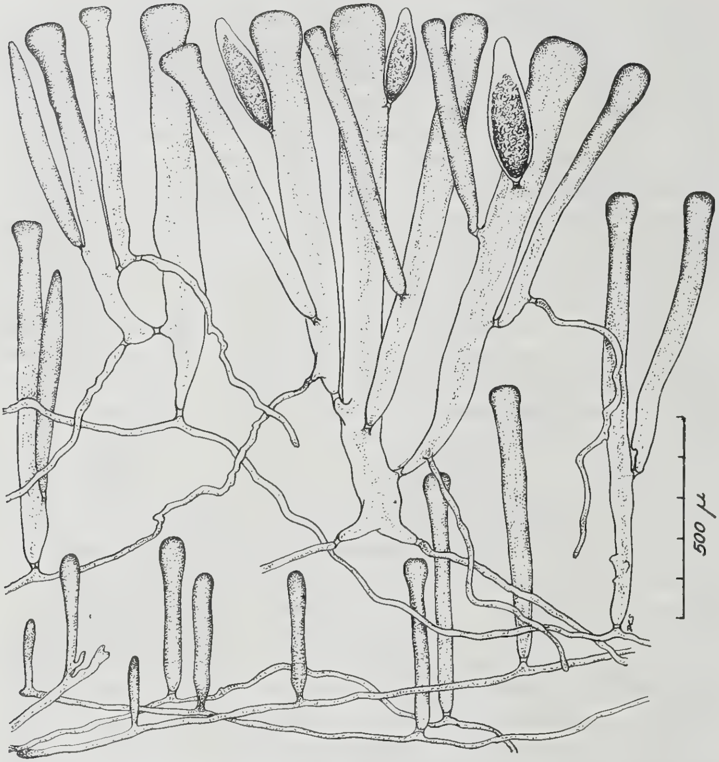

Fig. 9.—*C. pelliculare* (East London, C.P., *Papenfuss 321*). Mature (upper) and juvenile (lower) utricles.

cavus et arena impletus, ad 15 cm. diam. Utriculi primarii per amplificationem ramorum systematum sympodialium formati, obturaculium in loco originis e filamento evolutum; utriculi secondarii ut gemmae e parte media aut inferiore utriculorum primariorum vel derivativorum orientes, fasces parvos utriculorum genetice similium formantes; utriculi secondarii singuli interdum filamenta medullaria producentes, per excrescentiam tenuem e basi utriculi orientia, obturaculium in loco originis ex utriculo evolutum. Utriculi iuniores anguste clavati, ad apicem expansi, saepe infra apicem paululum constricti, (50—) 75—125 (—165) μ diam., 700—1,100 (—1,350) μ long.; utriculi vetustiores latiores, prope partem mediam saepe latissimi; apices truncati, depressi aut aliquantulum rotundati;

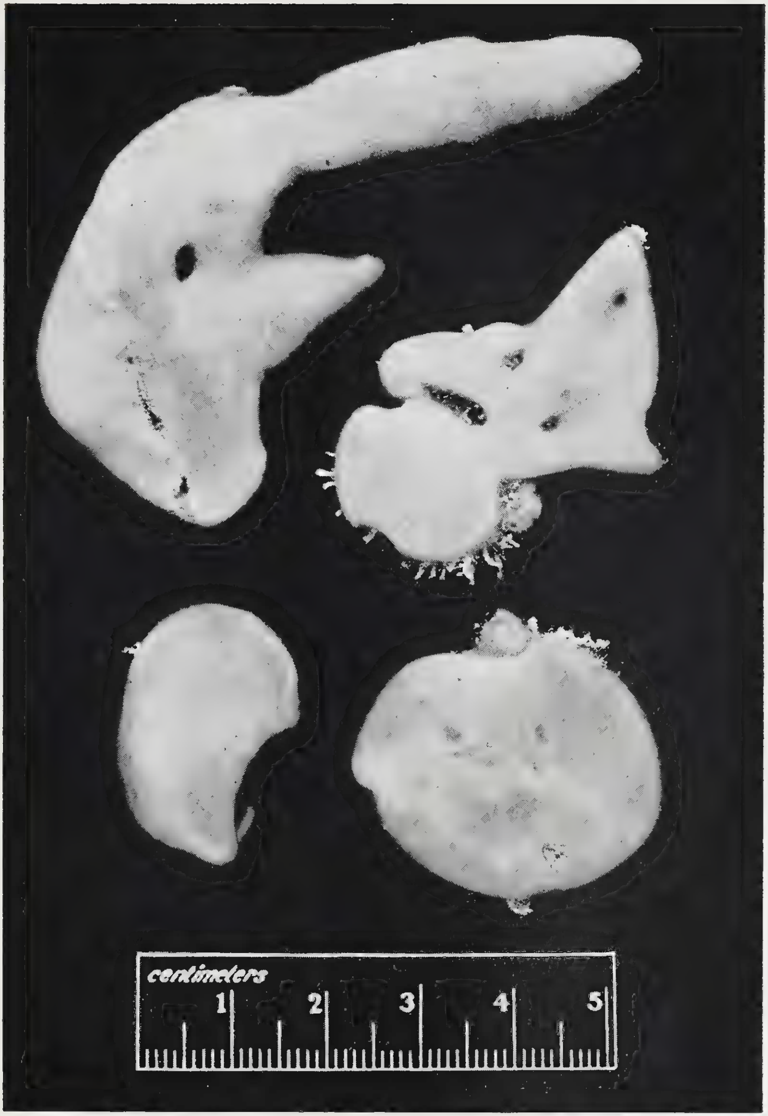

Plate VII. *Codium pelliculare.*
(Bats Cave Rocks, East London, C.P., *Papenfuss 321*=part of type collection in liquid preservative.)

membrana utricularis tenuis (1—1·5 μ) ad apices vix incrassata (—7 μ); utriculi secondarii pro portione minores. Pili absentes. Filamenta medullaria plerumque 12—25 μ diam. Gametangia lanceo-ovata ad fusiformia, 55—130 μ diam., 230—410 μ long., 1 (—3) per utriculum, omnia in pediculis circa 15—20 μ long., 265—440 μ infra apicem portata.

Thallus applanate, membraniform, thin (1·5—3 mm.), firm, rotund and with entire margins or with broadly rounded lobes, becoming hollow and filled with sand when old, to 15 cm. diam. Primary utricles formed by enlargement of branches of sympodial systems, plug developing at point of origin from filament; secondary utricles arising as buds from middle or lower portion of primary utricles or their derivatives, forming small clusters of utricles; secondary utricles sometimes each producing a medullary filament, arising by slender outgrowth from base of utricle, plug developing at point of origin from utricle. Younger utricles narrowly clavate, expanded at apex, often slightly constricted below apex, (50—) 75—125 (—165) μ diam., 700—1,100 (—1,350) μ long; older utricles of greater diameter, often broadest near middle; apices truncate, depressed, or slightly rounded; utricular wall thin (1—1·5 μ), at apices very slightly thickened (—7 μ); secondary utricles proportionately smaller. Hairs absent. Medullary filaments mostly 12—25 μ diam. Gametangia lanceovoid to fusiform, 55—130 μ diam., 230—410 μ long, 1 (—3) per utricle, each borne on pedicel about 15—20 μ long, 265—440 μ below apex of utricle.

Type.—East London (Bats Cave Rocks), Cape Province, 16.vii.1937, *Papenfuss 321* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Known Range.—Cape Province: Arniston to Port St. Johns.

Representative Collections Examined.—CAPE PROVINCE. Arniston, 20.ii.1939, *Pocock 524B*. Jeffreys Bay, 8.v.1927, *W. A. Setchell*. Riet River Mouth (Three Sisters), 2.x.1943, *Pocock 6943* (MAP). East London (Bats Cave Rocks), 10.vii.1937, *Ecol. Surv. L.59*. Morgan Bay, 3.x.1951, *Pocock 9450*. Cape Morgan, 29.ix.1939, *Pocock 1847* (MAP). Port St. Johns, 30.xii.1952, *Isaac B.484*.

This extraordinary species has escaped the notice of all but a few collectors. The single specimen collected by Setchell at Jeffreys Bay was designated by him as the type of a manuscript species, which he confused with material referable to *C. lucasii* subsp. *capense*. Setchell's notes read: "on sand-covered rocks, in littoral zone . . . the thallus is applanate, fairly smooth, and rather firm. It is attached over its entire lower surface, but comes away readily from the substratum because of the layer of sand beneath it. It is dark green in color and fairly regular [in] outline, orbicular to elongated elliptical." Dr. Papenfuss informs me that the thalli grow on a turf of stubby corallines and other algae in shaded pools on platforms of the lower littoral zone. The thallus is exceedingly thin, becoming translucent when dry.

C. pelliculare is unique in the genus both in gross morphology and in anatomy. Its membraniform habit is striking, and Miss Pocock has appropriately dubbed it the "beret" *Codium*. The clusters of utricles into which the thallus dissects are essentially the same in origin as those found occasionally in *C. bursa* and frequently in *C. megalophysum*: secondary sympodial systems abort to the degree that utricles are borne directly on parent utricles. This method of cluster formation is in fundamental distinction to that found in *C. acuminatum*, *C. mozambiquense*, *C. lucasii*, *C. stephensiae*, *C. incognitum*, *C. spongiosum*, *C. papenfussii* and all other members of the sections of the genus to which these species belong. (Sectional relationships are not discussed in this paper.) In these species secondary utricles (i.e., branch utricles) arise as buds from existing utricles. At the base of each utricle there is initiated by a broad outgrowth a single filament which either buries itself in the medulla or behaves as a sympodial branching system, giving rise to additional primary utricles: in either situation a plug is never formed at the point of origin of the filament. The extent of cluster formation in *C. pelliculare* is far greater than in either *C. megalophysum* or *C. bursa*. Moreover, there is a marked disparity in size among utricles of different orders of branching, which is not the case in those two species. Unlike *C. megalophysum*, in which nearly every utricle produces a filament (as part of a functional or abortive sympodial system), but like *C. bursa*, in *C. pelliculare* many derivative utricles do not produce such filaments. Finally, *C. pelliculare* is unique in that in sympodial systems a plug forms at the base of each developing utricle rather than at the point of departure of the lateral branch (new growing point) from the old apex, as in all other species of the genus.

10. **Codium platylobium** J. E. Areschoug, Nova Acta Reg. Soc. Sc. Upsal., ser. 3, 1: 367 (1854). De Toni 1889, p. 497. Barton 1893, p. 82 (Port Elizabeth, 1893, *Farquhar 1*, BM; Algoa Bay, 1884, *Herb. Dickie*, BM; Cape Morgan, 1892, *Flanagan 32*, BM). Papenfuss 1940, p. 204, fig. 4. Isaac 1942, p. 234. [Fig. 10, Plates VIII and IX]

C. elongatum C. Agardh δ *palmatifidum* Kuetzing, Sp. Alg. 501 (1849). (Type=Table Bay, *Binder*, L.)

C. lindenbergii Binder ex Kuetzing, Tab. Phyc. 6: 34, pl. 97 (1856). (Type=Table Bay, *Binder*, L.) J. Agardh 1887, p. 46. De Toni 1889, p. 497. Barton 1896, p. 194, excl. Port Elizabeth record (Cape Morgan, *Flanagan 248*, BM; Kowie, *H. Becker*, BOL). Delf and Michell 1921, p. 95, excl. False Bay record (Algoa Bay, East London, Kowie, *W. Tyson*,

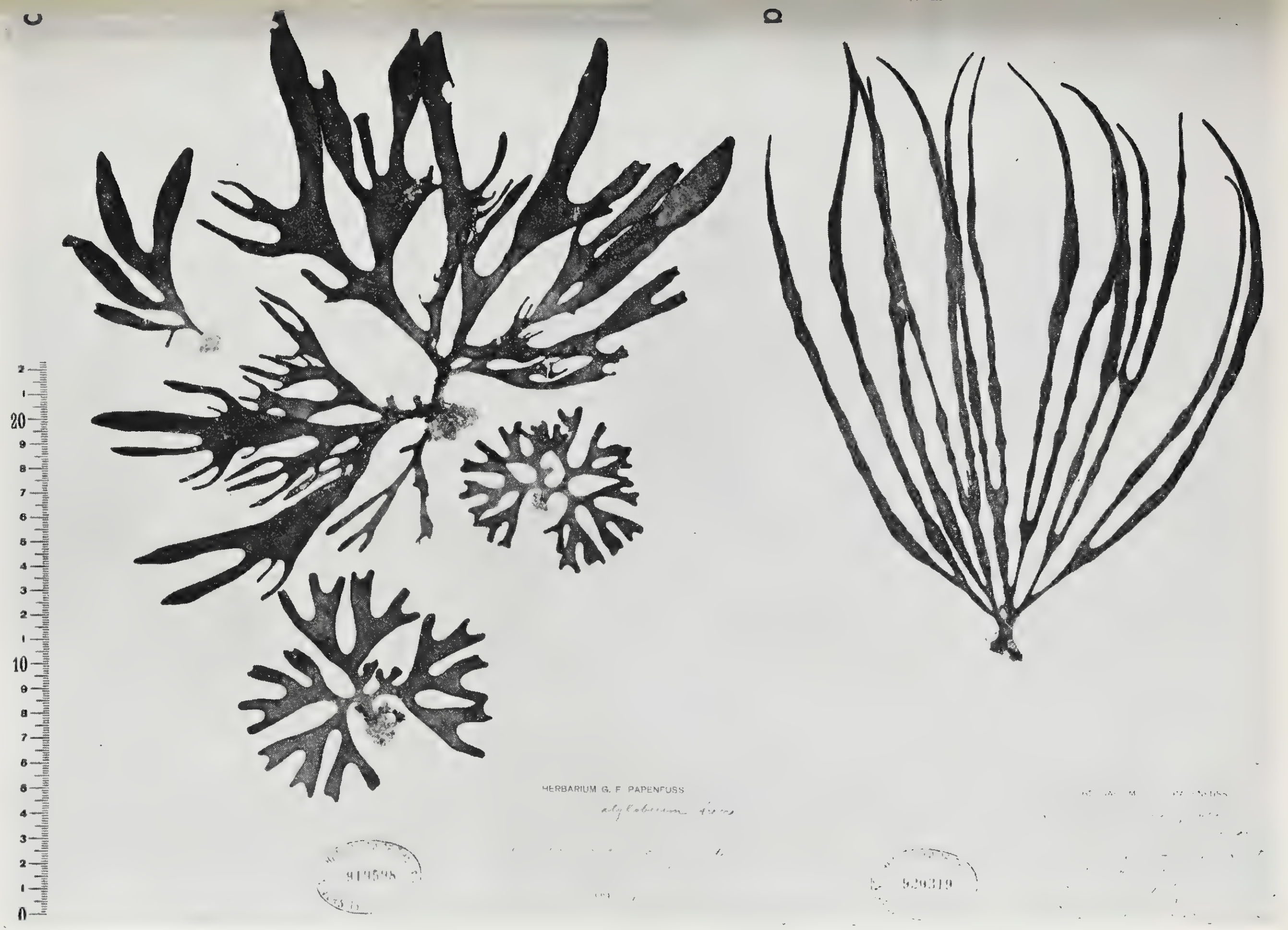

PLATE VIII. *Codium platylobium.*

a (Port St. Johns, C.P., *Pocock & Papenfuss 355*): plant with linear segments; *b* (Bats Cave Rocks, East London, C.P., *Papenfuss 337*): sheet with three young plants and an older proliferous plant.

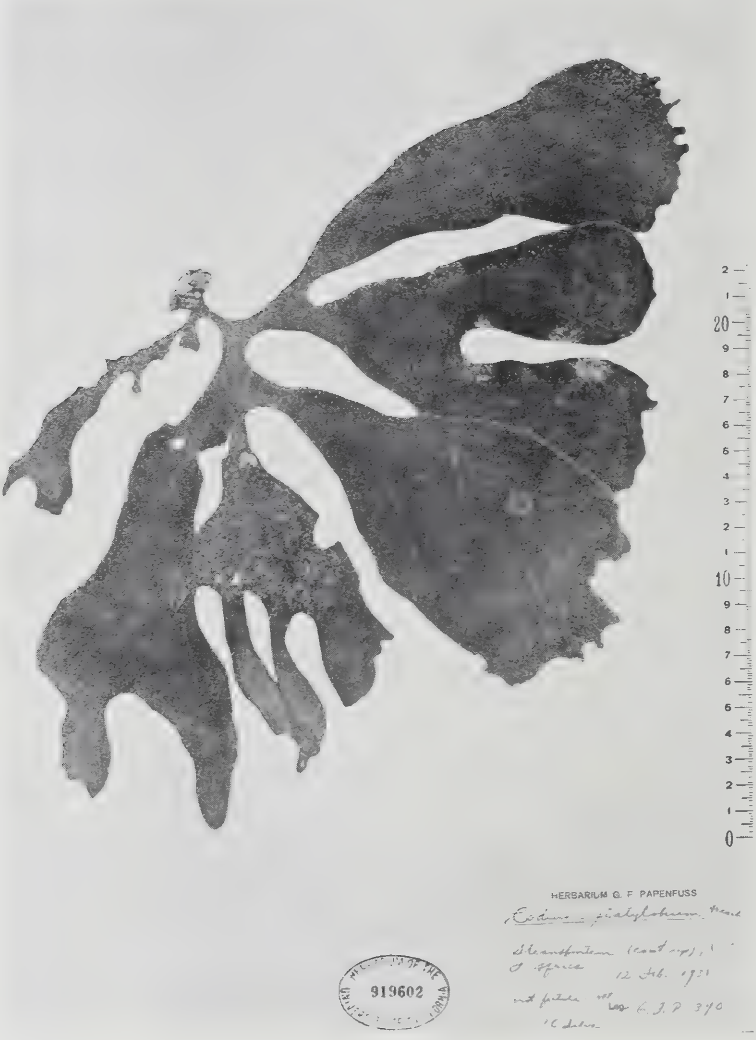

PLATE IX. *Codium platylobium.*

(Strandfontein, False Bay, C. P., *Papenfuss 340.*) Plant cast up from sublittoral with broad eroded segments becoming proliferous.

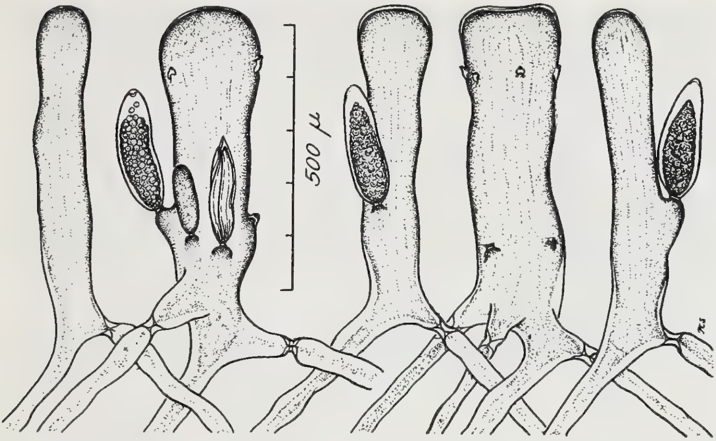

FIG. 10.—*C. platylobium* (Kalk Bay, C.P., *Papenfuss 344*). Mature utricles from standard sample.

BOL). Schmidt 1923, p. 60, fig. 43. Stephenson, Stephenson, and Bright 1938, pp. 5 and 7. Eyre, Broekhuysen, and Crichton 1938, p. 92. Pocock 1939, pp. 76 and 78. Stephenson 1939, p. 505. Stephenson 1944, pp. 317 and 349. Stephenson 1947, pp. 283 and 296.

Records Under Incorrect Determinations.—Kützing 1856, p. 34, pl. 98, as *C. damaecorne* (Kalk Bay, *Pappe*, L). Grunow 1867, p. 35, as *C. elongatum* var. *damaecornis* (Simons Bay, *Novara Exped.*, W). Barton 1893, p. 82, as *C. elongatum* (Kalk Bay, *Pappe*, L). Delf and Michell 1921, p. 95, as *C. tomentosum*, Table Bay record only (*W. Tyson*, BOL).

Excluded Records.—Barton 1893, p. 82, as *C. lindenbergii*=*C. fragile* subsp. *capense* (Cape of Good Hope, 1884, *Herb. Dickie*, BM). Barton 1896, p. 194, as *C. lindenbergii*, Port Elizabeth record only=*C. duthieae* (1893, *Farquhar 4*, BM). Delf 1921, p. 58, as *C. lindenbergii*=*C. stephensiae* (identity inferred from locality). Delf and Michell 1921, p. 95, as *C. lindenbergii*, False Bay record only=*C. stephensiae* (Gordons Bay, *W. Tyson*, BOL).

Thallus erect, entirely complanate and dichotomously branched (to eight orders) above a terete stipe; stipe 1—2·5 (—7) cm. long, terete at base, flattened above to form cuneate apophysis; segments of frond 3 mm. to 24 cm. broad, 1·5—2 mm. thick, to 2 m. long, linear-lanceolate, acute when young, becoming blunt from erosion when old, occasionally bearing simple or dichotomously divided proliferations on terminal and lateral margins. Thallus dissecting out into individual utricles; utricles* cylindrical or slightly clavate, usually expanded at apex, (65—) 115—330 (—460) μ diam., (375—) 500—750 (—840) μ long; apices truncate, depressed, or slightly rounded; utricular wall 1·5 μ thick, at apices slightly thickened (5—15 μ), rarely moderately thickened (—35 μ) and lamellate. Hairs (or hair scars) occasional, one to few per utricle, borne 80—140 μ below apex. Medullary filaments mostly 26—60 (—85) μ diam., usually several arising from base of older utricles by slender outgrowths. Gametangia lance-ovoid or ellipsoidal, 55—90 μ diam., 180—250 μ long, several per utricle, each borne on conspicuous pedicel at or below middle of utricle.

Type.—"Ad oram Africae australis in sinu Algoa prope Port Elisabeth . . . " (Areschoug). Lectotype chosen and figured by Papenfuss (1940) collected by Fr. Hjärne, ii.1854 (S).

Known Range.—Table Bay, Cape Province, to the mouth of the Umtwalumi River, Natal.

Representative Collections Examined.—CAPE PROVINCE. Table Bay, *W. Tyson* (BOL). False Bay: Froggy Pond, 24.i.1937, *Papenfuss 346*; Fish Hoek, 24.i.1937, *Papenfuss 347*; Kalk Bay, 20.vii.1936, *Papenfuss 344*; Strandfontein, 12.ii.1938, *Papenfuss 340*; Somerset Strand, iv.1929, *J. D. Rossouw.* Struis Bay Beach, 27.ii.1937, *Papenfuss 342.* Reef Bay (near Port Elizabeth), 5.vii.1936, *Ecol. Surv. E.30.* Humewood (near Port Elizabeth), 1.i.1937, *V. J. G. Steyn.* Port Elizabeth, *A. Weber-van Bosse* (L). Algoa Bay, *W. Tyson,* South African Marine Algae No. 55, as *C. lindenbergii* (BOL, HBG, K, PC, UC). Port Alfred, 4.vii.1896, *H. Becker* (BOL, M, PC). Kleinmond, 19.iii.1939, *Ecol. Surv. X.1.B.* East London (Shelly Beach), 8.vii.1937, *Ecol. Surv. L.34.* Bonza Bay, 27.vii.1937, *Papenfuss 341.* Morgan Bay, 1.x.1951, *Pocock 9403.* Keimouth, 22.vii.1937, *Papenfuss 170.* Qolora, 20.v.1939, *Ecol. Surv. QQ.1.U.* Dwessa, iv.1938, *Rayment 213A.* Bashee River Mouth, 26.ix.1939, *Pocock 1673.* Port St. Johns, 6.vii.1938, *Pocock & Papenfuss 355.* NATAL. Port Shepstone, 27.vii.1938, *Pocock & Papenfuss 248* (UC only). Hibberdene, 30.x.1951, *Pocock 9981.* Mouth of Umtwalumi River, 25.xii.1938, *Ecol. Surv. M.1.C.*

C. platylobium has been known, under various names, for more than a century. It was first described by Kützing (1849) as a variety of *C. elongatum*, based on a specimen in Binder's herbarium bearing the manuscript name *C. lindenbergii.* Kützing later (1856) recognized it as a distinct species, employing Binder's manuscript name. At the same time

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*Descriptions of utricles of dichotomously branched species are based on samples taken about 2 cm. below the tip of a branch ("standard sample"), unless otherwise specified.

he considered as a separate species a specimen collected by Pappe at Kalk Bay (not Table Bay, as erroneously cited by Kützing), assigning it to *C. elongatum* var. *damaecorne* Bory ex Montagne (1846), which he elevated to specific rank. Bory's variety (from Algeria), to judge from specimens in Herbier Bornet-Thuret (PC), is referable to *C. decorticatum* (Woodw.) Howe. The Kalk Bay specimen (Kützing 1856, pl. 98) is clearly referable to *C. platylobium* and is an old plant with broad, eroded segments bearing proliferations in contrast to the young plant with narrow, pointed segments illustrated by Kützing (pl. 97) as *C. lindenbergii*. Kützing remarked on the anatomical agreement, and obviously distinguished the two species on gross morphology. In the meanwhile Areschoug (1854) had described *C. platylobium*. J. Agardh (1887) was the first to merge all three species (*C. lindenbergii*, *C. damaecorne* sensu Kützing, and *C. platylobium*). He retained the name *C. lindenbergii*, but incorrectly, inasmuch as *C. platylobium* has priority, as emphasized by Papenfuss (1940).

In the eastern part of its range *C. platylobium* grows in pools and channels of the sublittoral fringe in partially protected situations. West of Jeffreys Bay it is known only from drift, except for one plant found attached at Strandfontein, indicating a deeper habitat in this part of its range (Stephenson 1947, p. 296). Specimens cast ashore generally are larger and have broader segments than those growing in the sublittoral fringe (compare Plates VII, *a* and VIII). Although rock is the usual substratum, plants epiphytic on sea grass, *Gelidium*, and other algae have been collected (Port Shepstone, *Pocock & Papenfuss 248*).

Hariot (1891, p. 216), following the suggestion of Suringar (1870, p. 22), reduced *C. latum* of Japan to *C. lindenbergii*, thereby initiating a series of incorrect records for the latter species (De Toni 1895, p. 64; Matsumura 1895, p. 88; Matsumura 1904, p. 52). In habit as well as in anatomy the two species are readily distinguishable, though clearly related. In *C. platylobium* the thallus is dichotomous to as many as eight orders and the segments are linear-lanceolate; the thallus of *C. latum* is simple or only once to thrice divided and the segments are reniform, falcate, or cuneate. The utricles of *C. platylobium* are much stouter than those of *C. latum*. Hariot did not have *C. latum* in hand, however; I agree with Yamada (1931, p. 1) that the specimen upon which Hariot's record is based (Yokosuka, *Savatier*, PC) is referable to *C. divaricatum* Holmes, a species which is not at all closely related to either *C. latum* or *C. platylobium*.

11. **Codium prostratum** Levring, Lunds Univ. Årsskr. 34 (Afd. 2, Nr 9): 16, pl. 4, fig. 11, text-figs. 8 *a—d* (1937). Eyre and Stephenson

1938, p. 33. Stephenson 1944, p. 349. Stephenson 1947, pp. 284 and 296. Pocock 1958, p. 25. [Fig. 11, Plate X]

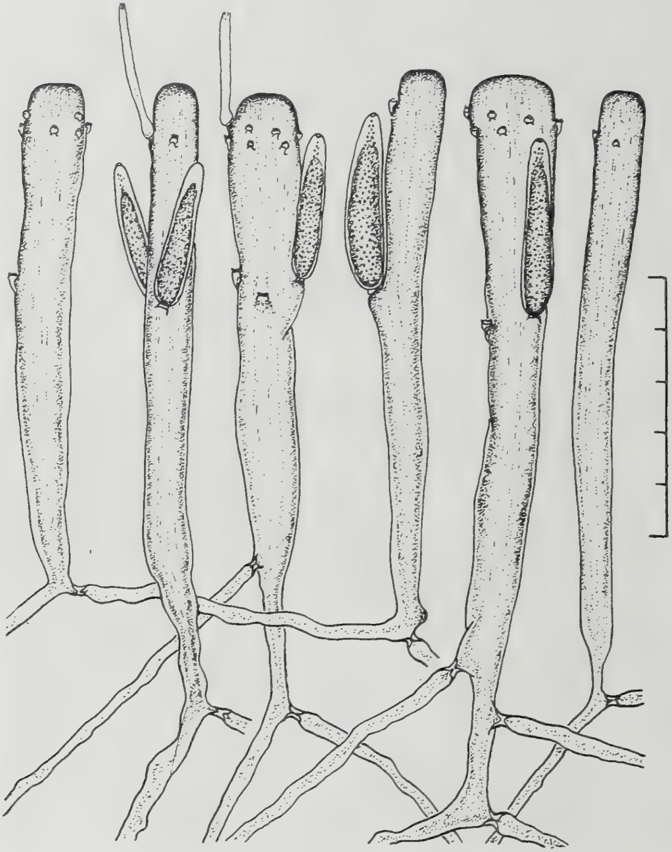

Fig. 11.—*C. prostratum* (Umhlali, Natal, *Ecol. Surv. U.19.B*). Mature utricles from standard sample.

Thallus repent (rarely erect), subdichotomously branched, to 16 cm. across; branches terete or somewhat compressed, finger-like, overlapping, anastomosing, 3—9 mm. thick. Thallus dissecting out into individual utricles; utricles subcylindrical or slightly clavate, often tapering markedly toward their base, 65—183 μ diam., 720—1,310 μ long, 6—14·5 × long as broad; apices truncate to slightly rounded; utricular wall about 1·5 μ

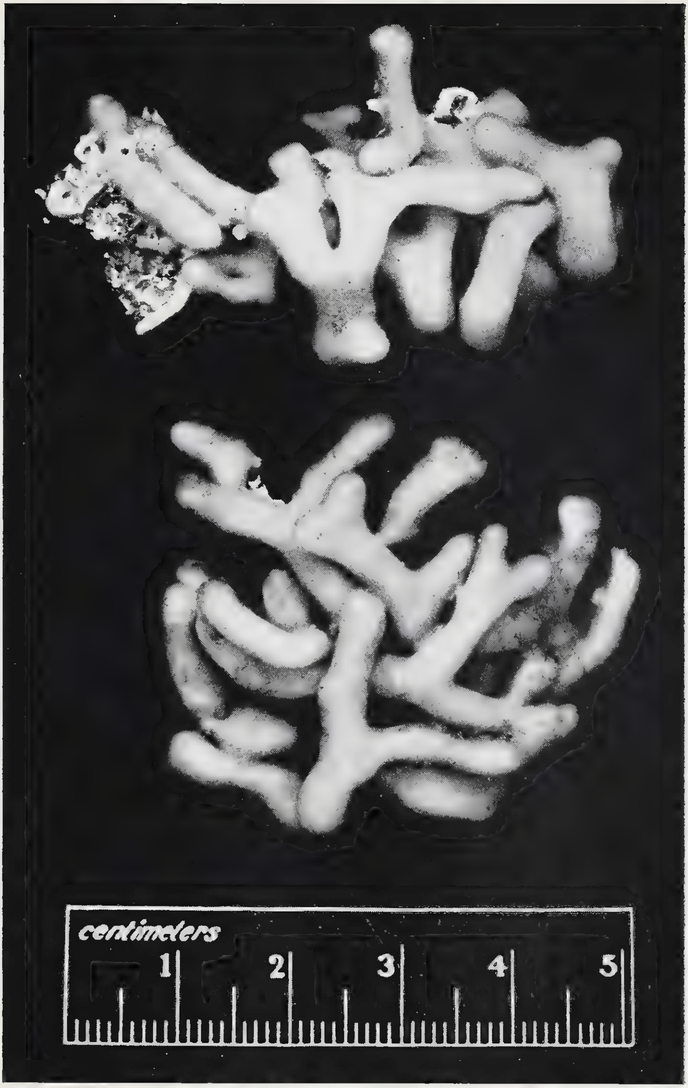

PLATE X. *Codium prostratum.*
(Umpangazi, Natal, *Ecol. Surv. G.5.A*: in liquid preservative.)

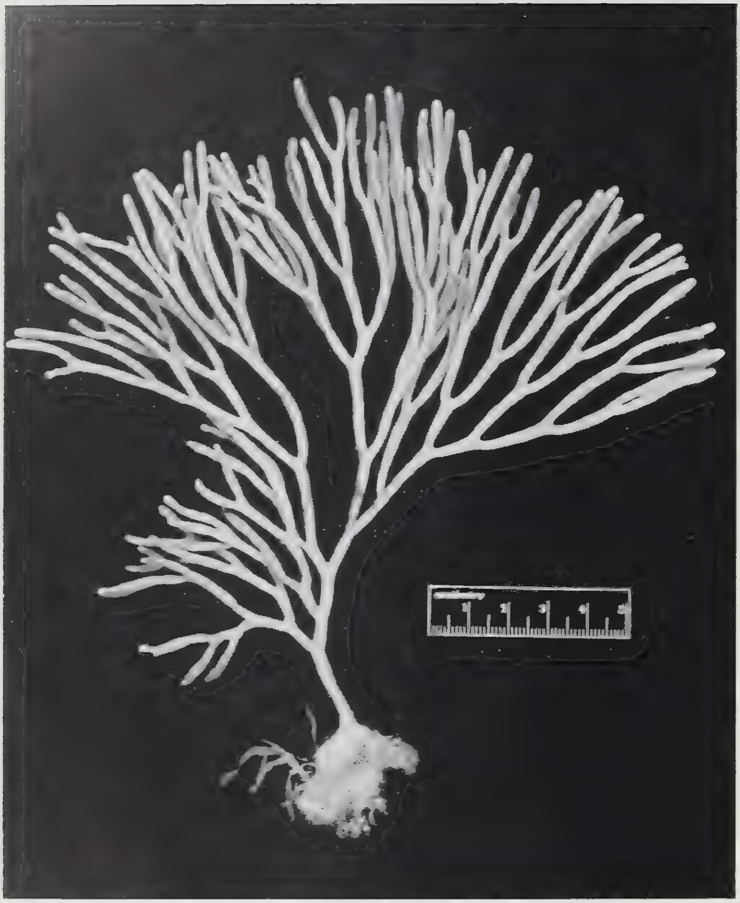

Plate XI. *Codium capitatum.*
(Umhlali, Natal, *Ecol. Surv. U.20.A*: in liquid preservative.)

thick, at apices usually very slightly thickened (to 2 or 3 μ), rarely moderately to markedly thickened (—35 μ). Hairs (or hair scars) abundant, one to several (—9) per utricle, borne in zone 80—130 μ below apex. Medullary filaments mostly 20—35 μ diam. Gametangia lance-ovoid or more usually subcylindrical, 33—72 μ diam., 235—365 μ long, 1—3 per utricle, each borne on pedicel about 7—9 μ long on protuberance 250—460 μ below apex of utricle.

Type.—Isipingo, Natal, 28.vi.1935, *Ecol. Surv. D.21* (Herb. Levring; isotype in CT).

Known Range.—Dwessa, Cape Province, to Cabo Inhaca, Mozambique.

Representative Collections Examined.—CAPE PROVINCE. Dwessa, 14.i.1953, *Isaac B.471.* Bashee River Mouth, 26.ix.1939, *Pocock 1672* Port St. Johns, 28.vii.1938, *Pocock & Papenfuss 352* (UC only). NATAL.. Port Shepstone, 27.vii.1938, *Pocock & Papenfuss 351* (UC only). Hibberdene, 30.x.1951, *Pocock 9983.* Reunion Rocks, 3.viii.1929, *E. Forbes.* Durban (The Bluff), 15.vii.1938, *Pocock & Papenfuss 353.* Umhlanga Rocks, 11.vii.1938, *Pocock & Papenfuss 349* (UC only). Umhloti Beach, 8.vii.1938, *Pocock & Papenfuss 1144.* Umhlali, 23.xii.1938, *Ecol. Surv. U.19.B.* Umpangazi, 4.v.1939, *Ecol. Surv. G.5.A.* Cape St. Lucia, x.1951, *Pocock 10596* (MAP). Sandstone reef near Big Kosi Bay, 25.v.1948, *Rodin 4630.* MOZAMBIQUE. Cabo Inhaca, v.1953, leg. W. Macnae, comm. *Pocock 10582.*

The repent, anastomosing, subdichotomously branching thallus of *C. prostratum* immediately distinguishes this species from all other representatives of the genus in South Africa. Anatomically, the long slender utricles are distinctive. *C. vaughanii* Børgesen (1940, p. 70) from Mauritius is a very close relative.

C. prostratum grows in pools and on sand-covered rock terraces of the lowest littoral zone.

12. **Codium capitatum** sp. nov.

C. collare Papenfuss, Ann. Natal Mus. 11: 283 and 296. 1947. *Nomen nudum. C. capitatum* Silva in Pocock in Macnae and Kalk (ed.), A Natural History of Inhaca Island, Moçambique, p. 24 (1958). *Nomen nudum.*

Records Under Incorrect Determinations.—Krauss 1846, p. 214, as *C. tomentosum*, Natal Bay record only ("Port Natal" [Durban], 1839, *Krauss*, AG, L, M). Areschoug 1851, p. 6, as *C. tomentosum*, Krauss reference only, pro parte. Barton 1893, p. 82, as *C. tomentosum*, Natal (*Krauss*) record only. Schmidt 1923, p. 40, as *C. tomentosum*, Port Natal (*Krauss*) record only. Vouk 1936, p. 19, as *C. dichotomum* f. *intermedium*,

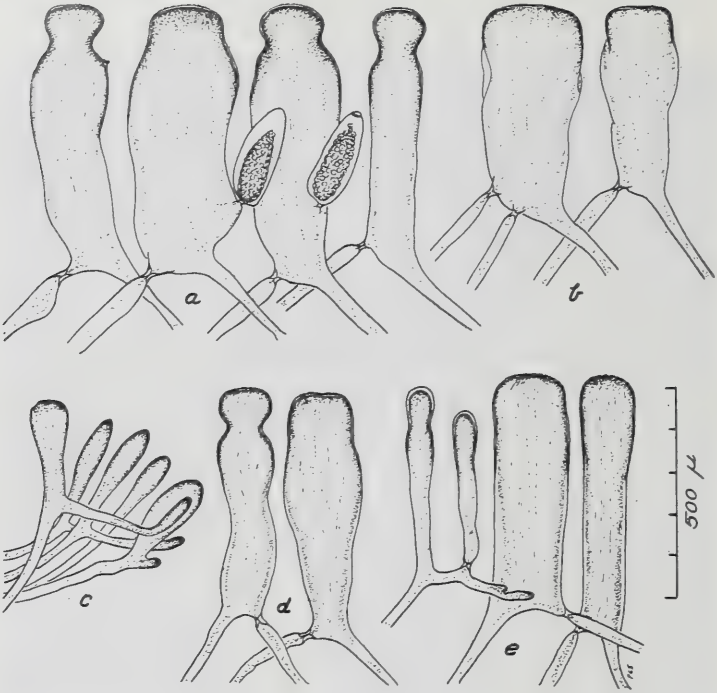

FIG. 12.—*C. capitatum*. *a* (Umhlanga Rocks, Natal, *Pocock & Papenfuss 231*= type), mature utricles from standard sample; *b* (Cape St. Lucia, Natal, *Pocock 10595*), mature utricles from standard sample; *c*, *d*, *e* (Umpangazi, Natal, *Ecol. Surv. G.1.K*): *c*, utricles from tip of thallus; *d*, utricles from standard sample; *e*, utricles from base of thallus.

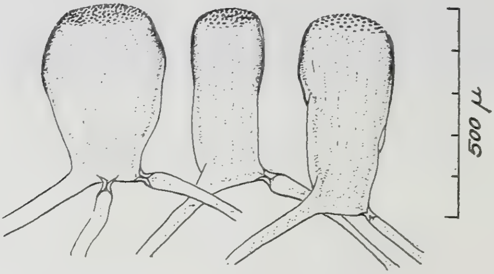

FIG. 13.—*C. capitatum* (Umhloti Beach, Natal, *Pocock & Papenfuss 230*). Utricles from standard sample.

Port Natal records only (B, annotated by Vouk). Levring 1938, p. 16, as *C. dichotomum*, pro parte; Eyre and Stephenson 1938, p. 33, as *C. dichotomum*, pro parte (Isipingo, *Ecol. Surv. D.4*, pro parte). Stephenson 1944, as *C. tenue*, p. 300; p. 350, pro parte; 1947, pp. 283 and 296, pro parte (Umhlali, *Ecol. Surv. U.20.A*).

Thallus erectus ad 35 cm. alt. proxime super basim haptericam latam spongiosam plus minusque regulariter dichotome ramosus; rami intervallis circa 3—4 mm. constrictiones saepe praebentes, aliter, autem, uniformiter teretes 2—3·5 mm. diam. Thallus extrinsecus in utriculos singulos dissectus; utriculi cylindrici aut paululum clavati, in regione 80—110 μ infra apicem capitulum formantes saepe perspicue constricti, interdum infra collum valde inflati, 100—215 μ diam. super constrictionem, 115—260 μ infra constrictionem, 340—715 μ long., 2—5 plo longiores quam lati, apicibus rotundatis; membrana utricularis 2 μ crass., in triente superiore utriculi conspicue incrassata facta, ad apicem ad 10 μ crass., plerumque externe verruculosa aut foveolata. Pili (aut pilorum cicatrices) rari, quando adsunt 1—2 (—4) per utriculum in zona 90—190 μ infra apicem in humero infra constrictionem dispositi. Filamenta medullaria plerumque 20—35 (—40) μ diam. Gametangia ovata aut ellipsoidea aut fusiformia, ad basem saepe asymmetrica, 70—105 μ diam., 170—285 μ long., 1—2 per utriculum, omnia in pediculis circa 8—12 μ long. in protuberatione circa 2/3 longitudinis utriculi ab apice (360—515 μ infra apicem) portata.

Thallus erect, to 35 cm. high, more or less regularly dichotomously branched immediately above a broad spongy hapteric base; branches often showing constrictions at intervals approximating 3—4 mm., but otherwise uniformly terete, 2—3·5 mm. diam. Thallus dissecting out into individual utricles; utricles cylindrical or slightly clavate, often distinctly constricted in region 80—110 μ below apex, forming a capitulum, at times markedly inflated below neck, 100—215 μ diam. above constriction, 115—260 μ diam. below constriction, 340—715 μ long, 2—5 × long as broad, with rounded apices; utricular wall 2μ thick, becoming conspicuously thickened in upper third of utricle, to 10 μ thick at apex, usually externally verruculose or foveolate. Hairs (or hair scars) not common, when present occurring 1—2 (—4) per utricle in zone 90—190 μ below apex, on shoulder below constriction. Medullary filaments mostly 20—35 (—40) μ diam. Gametangia ovoid, ellipsoidal, or fusiform, frequently asymmetrical at base, 70—105 μ diam., 170—285 μ long, 1—2 per utricle, each borne on pedicel about 8—12 μ long on protuberance about 2/3 length of utricle from apex (360—515 μ below apex).

Type.—Umhlanga Rocks, Natal, 10.vii.1938, *Pocock & Papenfuss 231* (UC; isotypes in BOL, BM, L, MAP).

Known Range.—Port St. Johns, Cape Province, to Cabo Inhaca, Mozambique.

Representative Collections Examined.—CAPE PROVINCE. Port St. Johns, 29.vii.1938, *Pocock & Papenfuss 244.* NATAL. Hibberdene, 30.x.1951, *Pocock 9984.* Isipingo, 27.vi.1935, *Ecol. Surv. D.4,* pro parte. Reunion Rocks, 13.x.1951, *Pocock 9514.* Durban (The Bluff), 15.vii.1938, *Pocock & Papenfuss 232.* Umhloti Beach, 9.vii.1938, *Pocock & Papenfuss 230.* Umhlali, 23.xii.1938, *Ecol. Surv. U.20.A.* Umpangazi, 2.v.1939, *Ecol. Surv. G.1.K.* St. Lucia (Crayfish Point), 21.vii.1938, *Pocock & Papenfuss 235* (UC only). Perrier's Rocks, 22.vii.1938, *Pocock & Papenfuss 348* (UC only). MOZAMBIQUE. Cabo Inhaca, v.1953, leg. W. Macnae, comm. *Pocock 10580.*

The earliest collection of *C. capitatum* is that by Krauss at Port Natal (Durban) in 1839, reported by him under the name *C. tomentosum.* In determinations made for the Ecological Survey this species was confused with *C. tenue.* The regularly capitate, often externally foveolate utricles set this species apart from all other dichotomous members of the genus. Utricles from lower parts of the thallus and those from juvenile plants are not so conspicuously capitate. The first 80—100 μ distance of utricle may be of uniform diameter, below which the utricle bulges, reaching a maximum diameter 185—220 μ below the apex. The most conspicuously foveolate or verruculose utricles seem to be those which are least conspicuously capitate. The thallus when being dissected has a keratinous texture. In the field this species is recognizable by its slender, regularly dichotomous branches whose diameter scarcely varies from base to apex, except for the regular constrictions exhibited by certain plants.

C. capitatum grows in the deeper pools of the platforms of the lower littoral zone.

13. **Codium pocockiae** sp. nov. [Fig. 14, Plate XII, *b*]

C. pocockiae Silva in Pocock in Macnae & Kalk (ed.), A Natural History of Inhaca Island, Moçambique, p. 25 (1958). *Nomen nudum.*

Records Under Incorrect Determinations.—Levring 1938, p. 16, as *C. dichotomum,* pro parte; Eyre and Stephenson 1938, p. 33, as *C. dichotomum,* pro parte (Isipingo, *Ecol. Surv. D.4,* pro parte; *D.21.A,* CT).

Thallus erectus, 4—10 cm. alt. divaricate dichotome ramosus, ramis ambobus dichotomiae plerumque non aeque evolutis, itaque ramificatio velut cervicornigera videtur, ramis latitudine inaequalibus, 3—7 mm. lat., quasi complanatis praecipue inferiore in parte. Thallus extrinsecus in utriculos singulos dissectus; utriculi clavati tenues (65—) 105—235

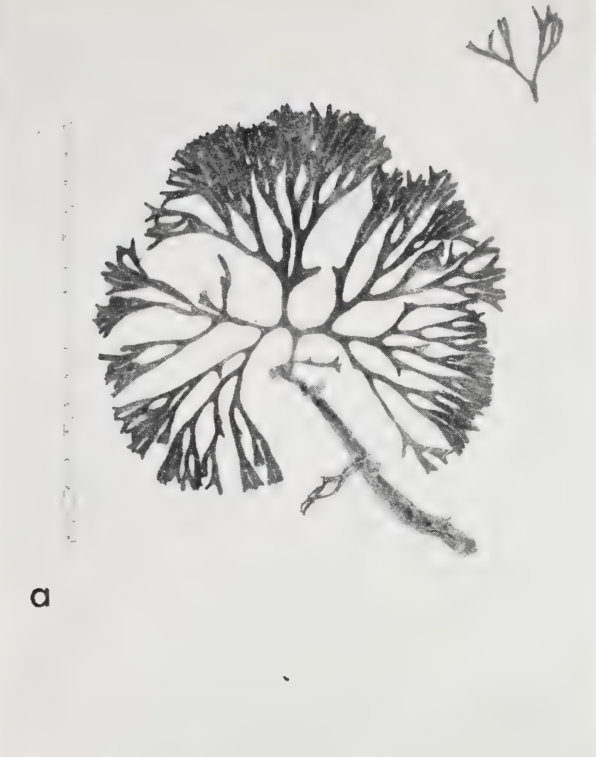

PLATE XII.
a, *Codium cicatrix* (Ponta Rasa, Mozambique, *Pocock 12279*=holotype); *b*, *Codium pocockiae* (Port St. Johns, C.P., *Pocock & Papenfuss 245*=holotype).

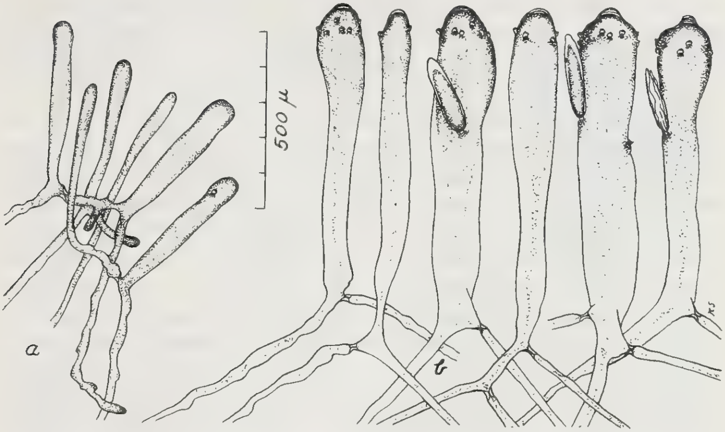

FIG. 14.—*C. pocockiae* (Cabo Inhaca, Mozambique, *Pocock 12288*). *a*, utricles from tip of thallus; *b*, utricles from standard sample.

(—300) μ diam., (500—) 650—1,050 (—1,250) μ long., apicibus rotundatis ad subacutos, membrana utricularis 1·5—2 μ crass., ad apices paululum ad modice incrassata (—35 μ), saepe asymmetrice incrassata, lamellata. Pili (aut pilorum cicatrices) frequentes, duo ad aliquot per utriculum, in zona 50—105 μ infra apicem portati. Filamenta medullaria plerumque 22—39 μ diam. Gametangia ellipsoidea, cylindrica aut lanceo-ovata (35—) 50—80 u diam., 225—260 (—350) μ long., 1—2 (—3) per utriculum, omnia in pediculis brevibus (circa 7 μ long.) in protuberatione parva (260—) 285—485 μ infra utriculi apicem portata.

Thallus erect, 4—10 cm. high, divaricately dichotomously branched, the two branches of a dichotomy usually not equally developed and the branching thus appearing cervicorn, branches of uneven width, 3—7 mm. broad, somewhat flattened, especially in lower part. Thallus dissecting out into individual utricles; utricles clavate, slender, (65—) 105—235 (—300) μ diam., (500—) 650—1,050 (—1,250) μ long, apices rounded to subacute; utricular wall 1·5—2 μ thick, at apices slightly to moderately thickened (—35 μ), often asymmetrically thickened, lamellate. Hairs (or hair scars) common, two to several per utricle, borne in zone 50—105 μ below apex. Medullary filaments mostly 22—39 μ diam. Gametangia ellipsoidal, cylindrical, or lance-ovoid, (35—) 50—80 μ diam., 225—260 (—350) μ long, 1—2 (—3) per utricle, each borne on short pedicel (about 7 μ long) on slight protuberance (260—) 285—485 μ below apex of utricle.

Type.—Port St. Johns, Cape Province, 29.vii.1938, *Pocock & Papenfuss 245* (UC).

Known Range.—Port St. Johns, Cape Province, to mouth of Limpopo River, Mozambique.

Representative Collections Examined.—CAPE PROVINCE. Port St. Johns, 30.vii.1938, *Pocock & Papenfuss 247* (UC only). NATAL. Port Shepstone, 27.vii.1938, *Pocock & Papenfuss 240* (UC only). Illovo River Mouth, xi.1894, *A. Weber-van Bosse* (L). Reunion Rocks, 13.x.1951, *Pocock 10602* (MAP). Isipingo, 27.vi.1935, *Ecol. Surv. D.4*, pro parte; *D.21.A* (CT). Umhloti Beach, 9.vii.1938, *Pocock & Papenfuss 366* (UC only). Umpangazi, 2.v.1939, *Ecol. Surv. G.4.B.* St. Lucia (Crayfish Point), 21.vii.1938, *Pocock & Papenfuss 365* (UC only). Kosi Bay, 25.v.1948, *R. J. Rodin.* MOZAMBIQUE. Cabo Inhaca, 26. ix. 1957, *Pocock 12288.* Vila de João Belo, near mouth of Limpopo River, viii.1936, *G. C. Nel.*

The long clavate utricles with markedly and often asymmetrically thickened apices distinguish this species anatomically. The disparity of size of utricles within a sample often is striking. In the field this species is readily distinguishable from all other members of the genus in South Africa by its divaricately dichotomous branching in which the two branches of a dichotomy are often very unequally developed and of uneven width. *C. pocockiae* is closely related to *C. taylori* Silva ined. (tropical and subtropical Atlantic), but differs in its narrower branches and the apices of the utricles, which are rounded to subacute rather than subtruncate.

C. pocockiae grows in pools and on more or less open rock at low tide level. At Cabo Inhaca it was found growing on the floor of a large pool in the low tide terrace in association with *C. acuminatum*, *C. lucasii* subsp. *capense*, *C. mozambiquense*, and *C. prostratum.*

It is a pleasure to name this species after Miss Pocock, in recognition of her extensive contributions to our knowledge of South African seaweeds and in appreciation of her unstinted co-operation during the course of this study.

14. **Codium tenue** (Kuetz.) Kuetzing, Tab. Phyc. 6: 33, pl. 95, fig. 1 (1856). J. Agardh 1887, p. 41 (excluding non-South African records). Delf and Michell 1921, p. 95 (Kowie, 4.v.1896, *H. Becker*, BOL; Hagahaga River Mouth, Cape Morgan, and Keimouth, *H. G. Flanagan*, BOL). Schmidt 1923, p. 50, fig. 34 (excluding non-South African records). Pocock 1955. Macnae 1957, pp. 124, 125, 131, and 363. [Fig. 15, Plate II, *b*]

C. tomentosum Stackh., ζ *tenue* Kuetzing, Sp. Alg. 501 (1849).

Records Under Incorrect Determinations.—Suhr 1834, p. 737, as *C.*

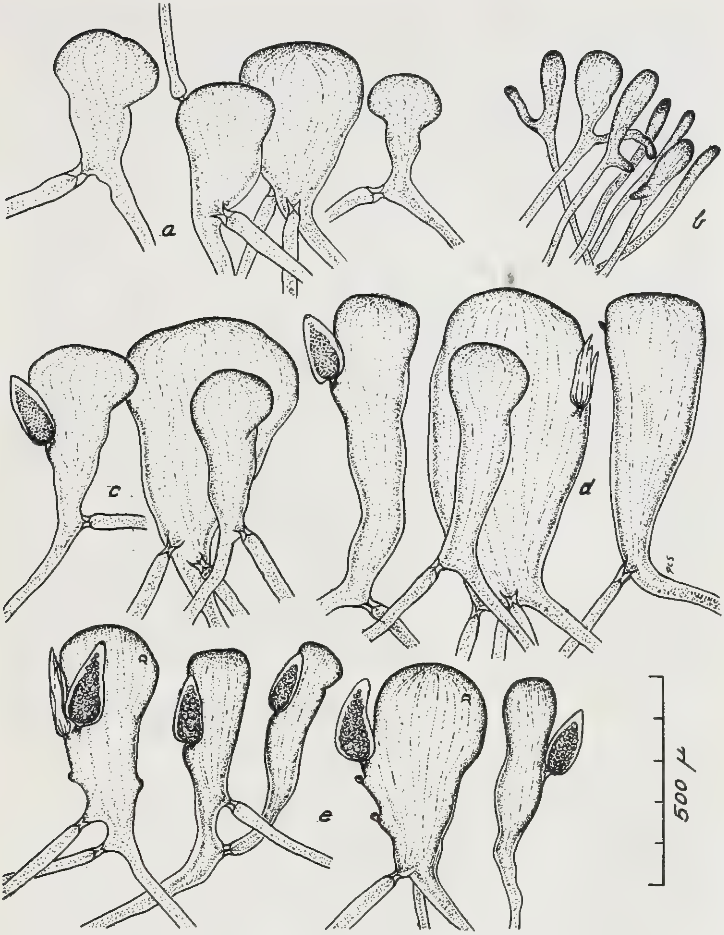

FIG. 15.—*C. tenue. a* ("Caput bonae spei," *Binder* = type), utricles from standard sample; *b, c, d* (Kowie River, C.P., *Pocock 10476*): *b*, utricles from tip of thallus; *c*, utricles from standard sample; *d*, utricles from base of thallus; *e* (Mouth of Zwartkops River, comm. *Pocock 10576*), utricles from standard sample.

tomentosum, pro parte ("Cap," *Zeyher*, S; Algoa Bay, *Zeyher*, S). Areschoug 1851, p. 6, as *C. tomentosum*, Suhr reference only, pro parte.

Excluded Records.—Barton 1893, p. 82=*C. extricatum* (Cape Agulhas, *Hohenacker*, Meeresalgen, No. 496, BM). Schmidt 1923, p. 50, Port

Natal (*Krauss*) record only=*C. capitatum* (B). Eyre, Broekhuysen, and Crichton 1938, p. 92=*C. extricatum* (East London, *Ecol. Surv. L.6*). Stephenson 1944, p. 300=*C. capitatum* (Umhlali, *Ecol. Surv. U.20.A*, etc.); p. 317=*C. extricatum* (Storms River, *Ecol. Surv. T.3.A*, etc.; p. 350= *C. capitatum* and *C. extricatum*. Stephenson 1947, pp. 283 and 296=*C. capitatum* and *C. extricatum*.

Thallus erect, bushy, light green, edges of younger branches translucent, to 45 cm. high. closely divaricately dichotomously branched (to 15 orders), interdichotomies terete, dichotomies flattened and expanded; infra-axillary dilations conspicuous in lower portion of thallus, to 2·2 cm. broad; interdichotomies 4—5 mm. diam. in lower portion of thallus, attenuated toward tips, which are 1—2 mm. diam. Thallus dissecting out into individual utricles; utricles just below tips turbinate, orbicular, obovate, or clavate, mostly 135—400 μ diam., 330—450 μ long; those in lower portion of thallus mostly of two forms: turbinate, quadrate, obovate, or pyriform, 400—700 μ diam., 600—800 μ long; and pyriform or clavate, 135—210 (—265) μ diam., 480—760 μ long; apices broadly rounded or slightly flattened; utricular wall 1·5 μ thick, at apices scarcely thickened (—2·5 μ). Hairs (or hair scars) frequently present, 1 (—3) per utricle, borne in zone 70—120 μ below apex. Medullary filaments mostly 20—40 (—50) μ diam., usually more than one emitting from base of each utricle. Gametangia ovoid or less often stoutly fusiform, 48—96 μ diam., 122—238 μ long, 1—2 (—3) per utricle, each borne on pedicel 7—12 μ long on slight protuberance 190—340 μ below apex (usually below middle of utricle).

Type.—"Ad Caput bonae spei. Specimen dedit cl. *Binder*" (Kützing), (L). Kützing cited the type locality as "Tafelbai," but this almost certainly is erroneous.

Known Range.—Cape Province: Knysna to Port St. Johns.

Representative Collections Examined.—CAPE PROVINCE. Knysna. 1894, *A. Weber-van Bosse* (L). Groot River Mouth, ii.1941, *Rhodes Univ. Coll. Exped.* (RU). Estuary of Zwartkops River, on small boulders and jetty piles at Amsterdam Hoek, 16.ii.1953, leg. W. Macnae, comm. *Pocock 10576*. Richmond (Boknes River lagoon), 30.viii.1942, *Pocock 6224*. Kariega River, on stones below causeway 10·5 mi. from sea, 16.ii.1943, *Pocock 6823*. Kowie River, 7.ix.1952, *Pocock 10476*. Kleinmond, lagoon, 13.v.1945, *Pocock 8392*. Cape Morgan, *H. G. Flanagan* (BOL). Port St. Johns (lighthouse rocks), 31.vii.1938, *Pocock & Papenfuss 354* (UC only); on *Padina* in high tide pool, 29.ix.1945, *Pocock 8815*,

The nature of this species has long been subject to much conjecture, even though the type specimen had been re-examined (by Schmidt and others). Consequently, the name has been applied to unrelated species from various parts of the world, especially Australasia. In South Africa it has been applied to *C. capitatum* and slender forms of *C. extricatum.* With the extensive collections now at hand, it has been possible to arrive at a satisfactory definition of the species. *C. tenue* is very distinctive, both morphologically and ecologically. The light green colour, divaricately dichotomous branching, regular infra-axillary dilations, and attenuated tips are outstanding features. The type specimen is but a fragment, the distal portion, of a thallus. Anatomically the small turbinate or quadrate utricles of the tenuous distal portions of the thallus have been considered typical of *C. tenue*, but they increase greatly in size in the lower thicker portions of the thallus, where they are intermixed with a second type of utricle, one whose shape is pyriform or clavate.

C. tenue occupies a unique habitat, growing on silt-covered rocks and shells and on concrete or wood jetty piles in river mouths (estuaries and lagoons). Formerly it was known only from the distal attenuated portions found in drift, but now it has been found attached at several localities. In the Kariega River large bushy plants grow as far as 10·5 miles upstream from the sea, both above and below the causeway, which is near the tidal limit. Details of its occurrence in the Zwartkops Estuary are given by Pocock (1955) and Macnae (1957). The only recorded exception to the estuarine habitat is the case of plants collected at Second Beach, Port St. Johns, in a high tide pool, associated with *Padina commersonii.* This exception may be accounted for by the fact that the stream from the marsh above this part of the beach enters the sea through this pool.

15. **Codium cicatrix** sp. nov. [Fig. 16, Plate XII, *a*]

Previous Record.—Pocock 1958, p. 24, as *C. papillatum.*

Thallus erectus ad 19 cm. alt. divaricate dichotome ramosus (ad novies), ramis teretibus ad basim 4—5 mm. diam., ad apices ad 2 mm. diam. gradatim attenuatis. Thallus extrinsecus in utriculos singulos dissectus; utriculi cylindrici aut saepius clavati (145—) 235—390 μ diam., 630—920 μ long.; apices subtruncati, saepe paululum depressi; membrana utricularis 1·5 μ crass., ad apices vix ad paululum incrassata (—17 μ). Pili (aut pilorum cicatrices) frequentes, aliquot ad plures per utriculum, in zona admodum infra apicem (ab apice ad 120 μ infra) portati; pili saepe abortivi, excrescentias cellulosae similes ad pilorum cicatricibus, sed rotundatas formantes. Filamenta medullaria plerumque 21—56 μ diam. Gametangia subcylindrica aut ellipsoidea ad crasse fusiformia, 65—120 μ diam., (235—) 300—330 μ long., 2—4 per utriculum, omnia in pediculis tenuibus 5—7 μ long. in protuberatione parva 300—420 μ infra utriculi apicem portata.

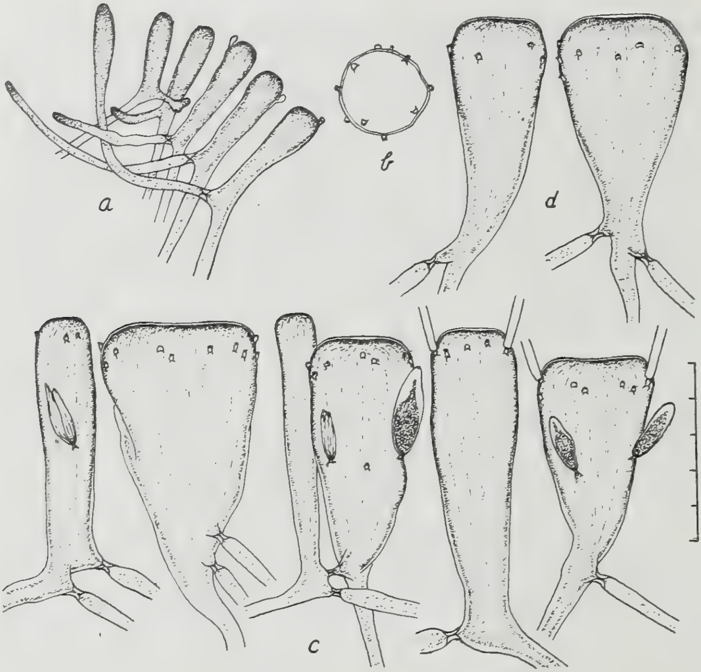

FIG. 16.—*C. cicatrix.* *a, b, c* (Ponta Rasa, Mozambique, comm. *Pocock 12279* = type): *a*, utricles from tip; *b*, top view of apex of utricle; *c*, utricles from standard sample; *d* (Barreira Vermelha, Mozambique, *Pocock 12264*), utricles from standard sample.

Thallus erect, to 19 cm. high, divaricately dichotomously branched (to 9 orders), branches terete, with translucent edges, 4—5 mm. diam. at base, tapering gradually to 2 mm. diam. at apices. Thallus dissecting out into individual utricles; utricles cylindrical or more usually clavate, (145—) 235—390µ diam., 630—920 µ long; apices subtruncate, often slightly depressed; utricular wall 1·5 µ thick, at apices very slightly to slightly thickened (—17 µ). Hairs (or hair scars) common, several to many per utricle, borne in zone immediately below apex (from apex to 120 µ below); hairs often abortive, forming cellulose outgrowths similar to hair scars, but rounded. Medullary filaments mostly 21—56 µ diam. Gametangia subcylindrical or ellipsoidal to stoutly fusiform, 65—120 µ diam., (235—) 300—330 µ long, 2—4 per utricle, each borne on slender pedicel 5—7 µ long on slight protuberance 300—420 µ below apex of utricle.

Type.—Sandbank covered with coral debris off Ponta Rasa, Inhaca Channel, Mozambique, on *Cymodocea ciliata*, 25.ix.1957, leg. W. Macnae, comm. *Pocock 12279* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Other Collections Examined.—MOZAMBIQUE. Delagoa Bay, viii.1935, *G. C. Nel.* Estação de Biologia Maritima, Ilha da Inhaca, on cement wall of sea-water intake, 11.xii.1955, *Pocock 11052* (MAP). Tidal flats between Estação and Ponta Punduini, Ilha da Inhaca, on *Cymodocea ciliata*, 12.xii.1955, *Pocock 11069.* Coral reef off Barreira Vermelha, drift, 25.ix.1957, *Pocock 12264.*

Anatomically the material referred to this species is very similar to *C. papillatum* Tseng and Gilbert (1942) from the Philippines. The most conspicuous feature is the abundance, just below the apex of the utricle, of hair "scars", some of which would appear to represent aborted primordia rather than scars. As in *C. papillatum*, these outgrowths cause the utricles to adhere to one another to the extent that in any sample one to several broken upper portions of utricles may be observed, giving a vertical view rather than the usual lateral view of the apex of the utricle. In habit, however, *C. cicatrix* is very different from *C. papillatum*, which is cervicorn with flattened segments.

16. **Codium extricatum,** sp. nov. [Fig. 17, Plates XIII and XIV]

Records Under Incorrect Determinations.—Suhr 1834, p. 737, as *C. tomentosum*, pro parte ("Cap," *Zeyher*, S). Areschoug 1851, p. 6, as *C. tomentosum*, Suhr reference only, pro parte. Barton 1893, p. 82, as *C. tenue* (Cape Agulhas, *Hohenacker*, Meeresalgen No. 496,* BM). Delf and Michell 1921, p. 95, as *C. tomentosum*, Cape Morgan record, pro parte ("seashore near Keimouth," 1892, *H. G. Flanagan*, BOL). Eyre, Broekhuysen, and Crichton 1938, p. 92, as *C. tenue* (East London, *Ecol. Surv. L.6*). Stephenson 1944, as *C. tenue*, p. 317; p. 350, pro parte; 1947, pp. 283 and 296, pro parte (Storms River, *Ecol. Surv. T.3.A*; etc.).

Thallus erectus ad 50 cm. alt. dichotome ramosus (octies ad quaterdecies), dichotomiis confertis aut distantibus, rami in parte thalli inferiore plerumque complanari solent, supra subteretes teretesve, ad basem ad 8 mm. latos, ad 1·5—2 mm. diam. ad apices gradatim attenuati. Thallus

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*Plants distributed as No. 496 of R. F. Hohenacker's Algae marinae siccatae, Lieferung X (1862), under the name *C. tomentosum* var. *tenue* Kuetz., allegedly from Cape Agulhas, comprise a heterogeneous assortment of materials. Six species have been detected, as follows: *C. capitatum* (WU) [undoubtedly from Natal]; *C. isaacii* (PC) [probably from Table Bay]; *C. extricatum* (BM, M), and *C. fragile* subsp. *capense* (W, WU) [possibly from Cape Agulhas]; *C. tomentosum* (W) and *C. vermilara* (FI, L, M, NY, UC) [this material probably is the residue of that which was distributed as No. 59, "*C. tomentosum*", from Cherbourg, which is a mixture of *C. tomentosum* and *C. vermilara*].

extrinsecus in utriculos singulos dissectus; utriculi subcylindrici ad clavatos, (88—) 125—280 (—325) μ diam., 450—880 μ long., 2·5—4·5 (—6·5) plo longiores quam lati, apicibus truncatis, subtruncatis, depressis aut paululum rotundatis; membrana utricularis circa 2 μ crassa,

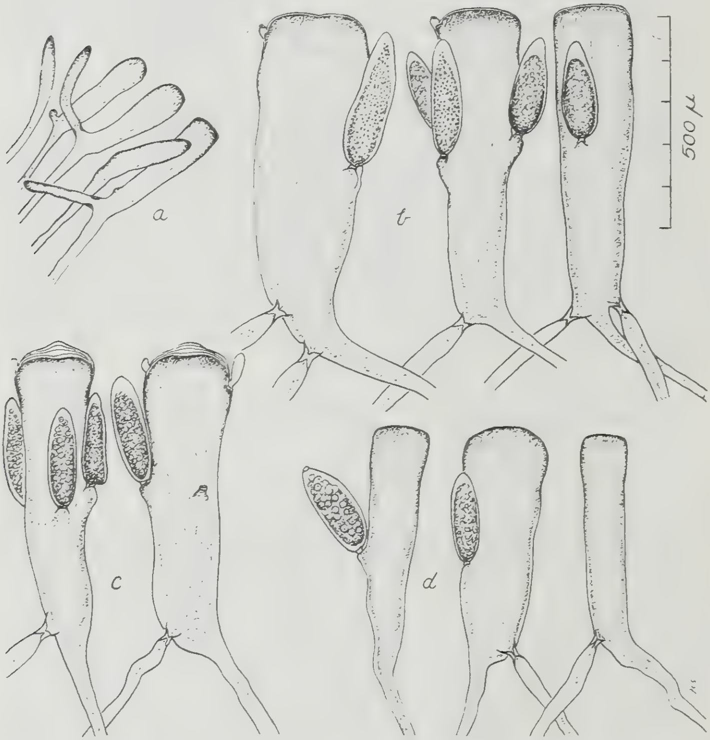

FIG. 17.—*C. extricatum. a, b* (Qolora, C.P., *Pocock 10546* = type): *a*, utricles from tip of thallus; *b*, utricles from standard sample; *c* (Struis Bay Beach, C.P., *Papenfuss 89*), utricles from standard sample; *d* (Kasouga, C.P., *Pocock 10588*), utricles from standard sample.

ad apicem vix (5—6 μ), modice (—15 μ) aut valde (—65 μ) incrassata, apicibus incrassatis conspicue lamellatis, interdum paululum introrse umbonatis. Pili (aut pilorum cicatrices) frequentes, unus ad aliquot per utriculum, in zona 40—100 μ infra apicem portati. Filamenta medullaria plerumque 20—40 μ diam. Gametangia lance-ovata, ellipsoidea aut

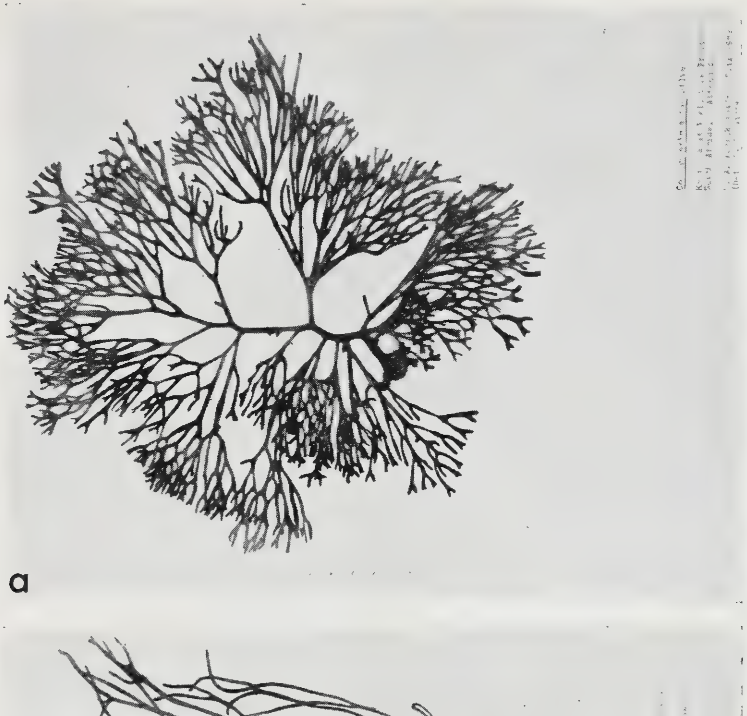

PLATE XIII. *Codium extricatum.*

a (Salt Vlei, Kowie, C.P., *Pocock 10472*): plant with congested, wholly terete branches; *b* (Qolora, C.P., *Pocock 10546*=holotype): upper dichotomies distant, lower dichotomies less distant and somewhat flattened.

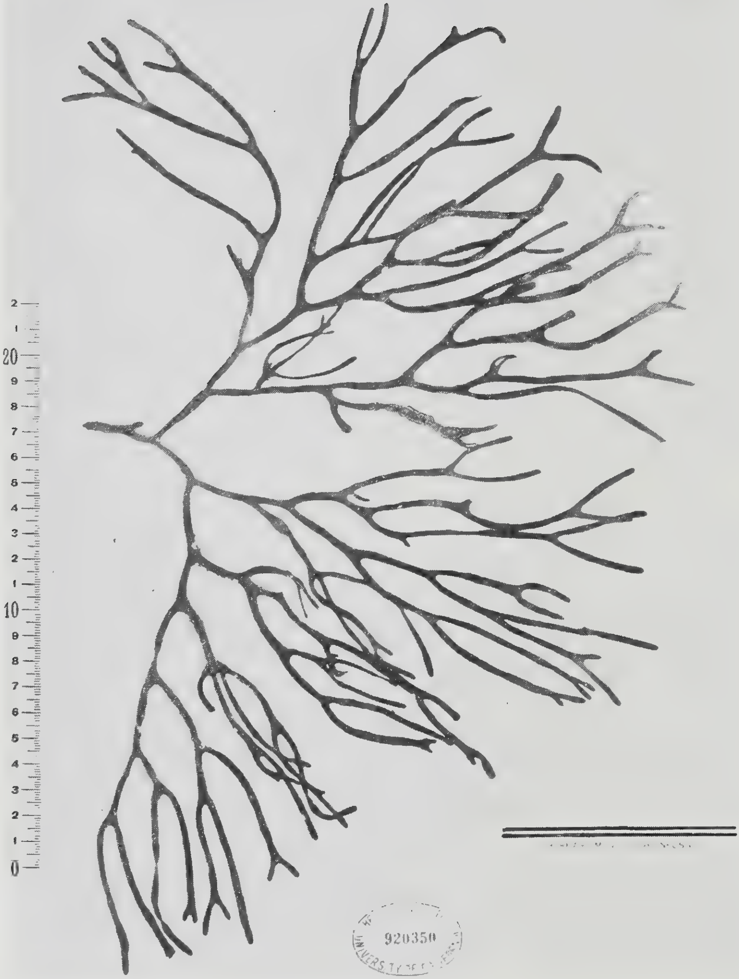

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Plate XIV. *Codium extricatum.*
(Struis Bay Beach, C.P., *Papenfuss 89.*) Plant cast up from sublittoral with close, wholly terete branches.

cylindrica 55—100 (—150) μ diam., 240—330 μ long., 1—3 per utriculum, omnia in pediculis circa 8—12 μ long. in protuberatione 270—410 μ infra utriculi apicem (prope utriculi mediam partem) portata.

Thallus erect, firm, very dark green, to 50 cm. high, dichotomously branched (8—14 orders), dichotomies close or distant, branches tending to be flattened in lower part of thallus, subterete or terete above, to 8 mm. broad at base, tapering gradually to 1·5—2 mm. diam. at apices. Thallus dissecting out into individual utricles; utricles subcylindrical to clavate, (88—) 125—280 (—325) μ diam., 450—880 μ long, 2·5—4·5 (—6·5) × long as broad, with truncate, subtruncate, depressed, or slightly rounded apices; utricular wall ca. 2 μ thick, at apex slightly (5—6 μ), moderately (—15 μ), or markedly (—65 μ) thickened, incrassate apices conspicuously lamellate, at times slightly introrsely umbonate. Hairs (or hair scars) common, one to few per utricle, borne in zone 40—100 μ below apex. Medullary filaments mostly 20—40 μ diam. Gametangia lance-ovoid, ellipsoidal, or cylindrical, 55—100 (—150) μ diam., 240—330 μ long, 1—3 per utricle, each borne on pedicel about 8—12 μ long on protuberance 270—410 μ below apex of utricle (near middle of utricle).

Type.—Mouth of Qolora River, Cape Province, 4.x.1952, *Pocock 10546* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Known Range.—Cape Agulhas, Cape Province, to Umpangazi, Natal.

Representative Collections Examined.—CAPE PROVINCE. Cape Agulhas, *Hohenacker*, Meeresalgen No. 496 (BM). Struis Bay Beach, cast ashore, 1.iii.1937, *Papenfuss 89.* Arniston, 20.ii.1939, *Pocock 525* (UC only). Groot River Mouth (Blue Rocks), 29.vi.1942, *Pocock 6438* (MAP). Storms River Mouth, 2.iv.1939, *Ecol. Surv. T.3.A.* Jeffreys Bay, 8.v.1927, *W. A. Setchell.* Reef Bay, near Port Elizabeth, 5.vii.1936, *Ecol. Surv. E.31.* Algoa Bay, 1837, *Zeyher* (HBG). Richmond, 24.iii.1939, *Ecol. Surv. Y.1.T.* Bushman's River Mouth, 1.vi.1942, *Pocock 6091.* Kariega Rocks, 19.ii.1943, *Pocock 6924.* Kasouga (Ship Rock), 1.iii.1953, *Pocock 10588.* Sharks Bay, 21.ix.1952, *Pocock 10503* (UC only). Cove Rock, 18.vii.1943, *Pocock 7361.* East London (Shelly Beach), 6.vii.1937, *Ecol. Surv. L.6.* Black Rock, just east of Hagahaga, i.1941, *Pocock 3679.* Morgan Bay, 5.x.1951, *Pocock 9454.* Keimouth, 22.vii.1937, *Papenfuss 369.* Bashee River Mouth, 27.ix.1939, *Pocock 1693.* NATAL. Port Shepstone, 27.ix.1953, *Pocock & Papenfuss 241.* Umhlali (Salt Rock Beach), 24.ix.1953, *Isaac B.486.* Umpangazi, 5.v.1939, *Ecol. Surv. G.6.B.*

C. extricatum shows considerable variation in size, in thickness, and degree of flattening of branches, and in size and degree of thickening of apical walls of utricles. It grows in somewhat sheltered deep tide pools and, more luxuriantly, on rocks in the open sea (exposed to full surf at Black Rock).

17. **Codium duthieae** Silva, Austral. Journ. Bot. 4: 275, fig. 10; pl. 1, fig. 2 (1956). The following South African references are under the name *C. duthieae* Setchell (or Setch. ex Papenfuss), a *nomen nudum:* Stephenson, Stephenson, and du Toit 1937, p. 372. Eyre and Stephenson 1938, p. 33 (Isipingo, *Ecol. Surv. D.36*). Eyre, Broekhuysen, and Crichton

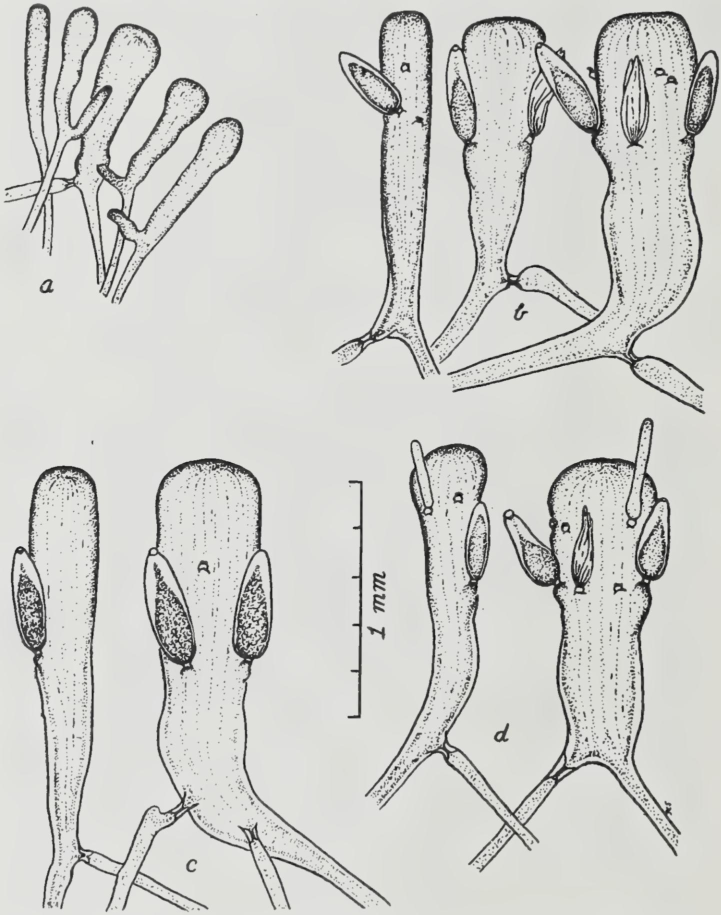

FIG. 18.—*C. duthieae. a, b* (Strandfontein, False Bay, C.P., *Papenfuss 24*): *a*, utricles from tip of thallus; *b*, utricles from standard sample; *c* (Kowie, C.P., *Pocock 10505*), utricles from standard sample; *d* (Isipingo, Natal, *Ecol. Surv. D.36*), utricles from standard sample.

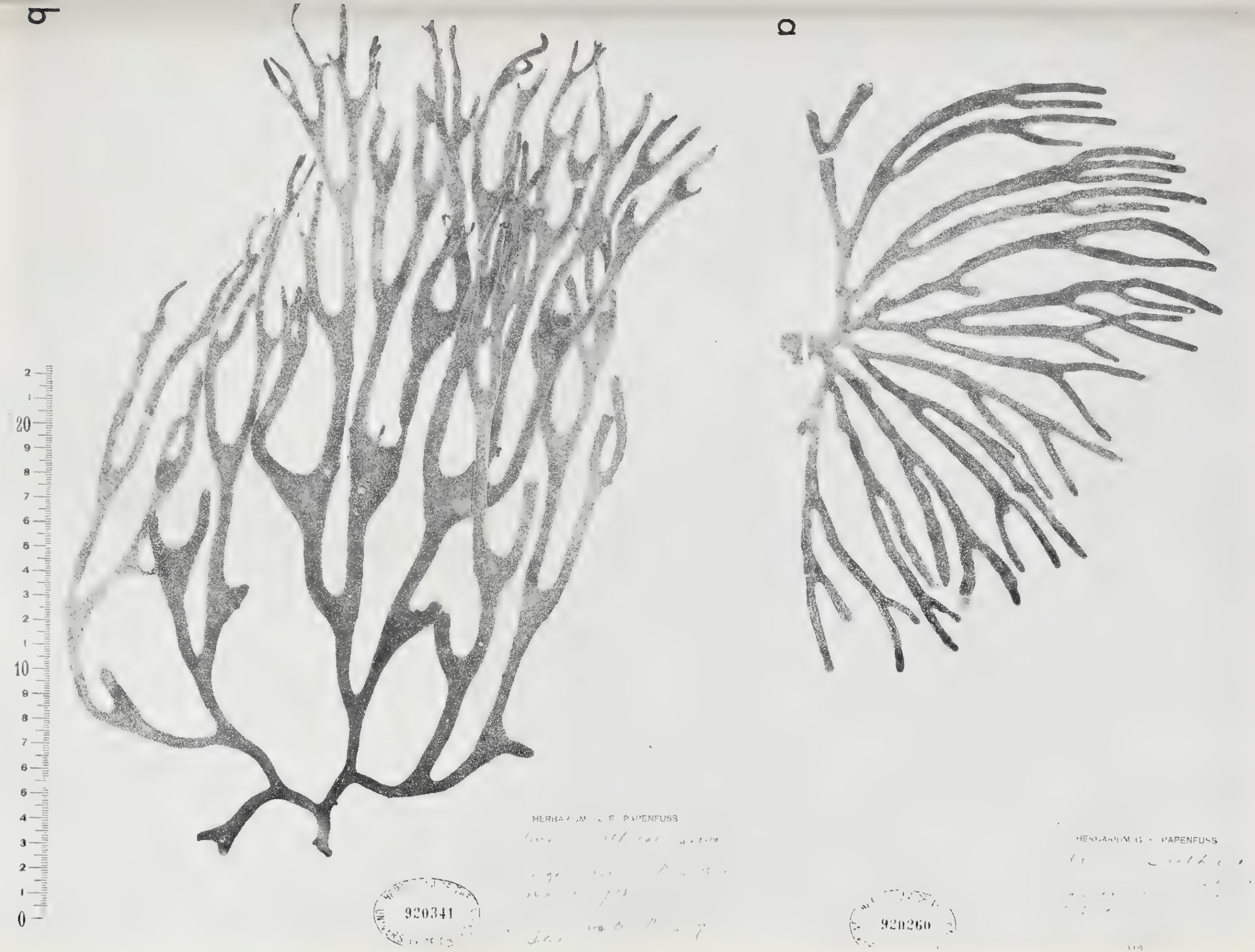

PLATE XV. *Codium duthieae.*

a (Strandfontein, False Bay, C.P., *Papenfuss 24*=holotype): plant with usual terete branches; *b* (Langebaan, C.P., *Papenfuss* [illegible]): plant

1938, p. 92 (East London, *Ecol. Surv. L.7*). Eyre 1939, p. 296. Pocock 1939, p. 78. Stephenson 1944, pp. 300 and 317; 336 (pro parte); 349 (pro parte). Stephenson 1947, pp. 283 and 296 (pro parte). [Fig. 18, Plate XV]

Records Under Incorrect Determinations.—Harvey 1838, p. 404, as *C. tomentosum*, pro parte ("C. b. sp.," *W. H. Harvey*, K). Barton 1893, p. 82, as *C. tomentosum*, pro parte ("Pr. b. sp.," *Gueinzius*, BM; Keimouth, 1892, *H. G. Flanagan*, BM). Barton 1896, p. 194, as *C. lindenbergii*, Port Elizabeth record only (1893, *Farquhar 4*, BM). Delf 1921, pp. 58 and 62, as *C. tomentosum*, pro parte (see "Unverified Records"). Delf and Michell 1921, p. 95, as *C. tomentosum*, Bomvanaland Coast (vi.1897, *Mrs. Filmer*, BOL) and Cape Morgan ("seashore near Keimouth," 1892, *H. G. Flanagan*, BOL, pro parte) records only.

Excluded Record.—Stephenson, Stephenson, and Day 1940, p. 355= *C. isaacii* (identity inferred from locality).

Thallus erect, to 60 cm. high, dichotomously branched; branches wholly terete, flattened only at dichotomies, or flattened almost throughout; interdichotomies 3—14 mm. broad, dichotomies to 40 mm. broad. Thallus dissecting out into individual utricles; utricles cylindrical to clavate, noticeably variable in diameter in any one sample, (130—) 176—500 (—720) μ diam., 800—1,800 μ long; apices broadly rounded or subtruncate; utricular wall 2 μ thick at base of utricle, gradually thickening toward apex, usually 6—10 μ thick at apex, occasionally moderately to markedly thickened (—42 μ). Hairs (or hair scars) occasional, at times fairly numerous (to 12 per utricle), borne in zone 185—430 μ below apex of utricle. Medullary filaments mostly 43—72 μ diam. Gametangia lance-ovoid, 70—180 μ diam., (235—) 270—430 (—500) μ long, several (—8) per utricle, each borne on pedicel about 15 μ long on protuberance 345—675 μ below apex of utricle.

Type.—Strandfontein, False Bay, Cape Province, 13.xi.1935, *Papenfuss 24* (UC; isotype in BOL).

Known Range.—Saldanha Bay; Table Bay, Cape Province, around the Cape of Good Hope to the mouth of the Limpopo River, Mozambique. Australia.

Representative South African Collections Examined.—CAPE PROVINCE. Langebaan, 3.iii.1938, *Papenfuss 257*. Camps Bay, 1.ix.1936, *Papenfuss 26*. False Bay: Kalk Bay, 20.vii.1936, *Papenfuss 19*; Strandfontein, 24.xi.1936, *Papenfuss 363*; Somerset Strand, 23.iv.1935, *A. V. Duthie*. Cape Agulhas, 28.ix.1939, *Ecol. Surv. AG.5.C*. Struis Bay Beach, cast ashore, 1.iii.1937, *Papenfuss 91*. Arniston, 23.xi.1939, *Ecol. Surv. AR.1.B, A.R.1.C*. White Sands, *M. E. Rademan*. Still Bay, ix.1934, *C. J. van der Merwe*. Little Brak River Mouth, vi.1939, *T. F. Gericke*.

Buffalo Bay, 29.i.1944, *Pocock 7879.* Knysna, 1842, *F. Krauss* (FI). Plettenberg Bay, 29.vi.1937, *Papenfuss 364.* Storms River Mouth, 25.i.1940, *Ecol. Surv. TT.7.B.* Jeffreys Bay, 28.iii.1939, *Ecol. Surv., Z.2.C.* Port Elizabeth, 30.vi.1937, *Papenfuss 360.* Bushman's River Mouth, vii.1937, *P. M. de Vos.* Kariega Rocks, 19.ii.1943, *Pocock 6923.* Kasouga (Ship Rock), 1.iii.1953, *Pocock 10586.* Kowie (Sharks Bay), 21.ix.1952, *Pocock 10609.* Port Alfred, iii.1870, *H. Becker* (BOL). Kleinmond, 19.iii.1939, *Ecol. Surv. X.1.D.* Waterloo Bay, 3.iv.1942, *Pocock 4960.* East London, 7.vii.1937, *Ecol. Surv. L.7.* Bonza Bay, 27.vii.1937, *Papenfuss 361.* Keimouth, 22.vii.1937, *Papenfuss 169.* Qolora, 4.x.1952, *Pocock 10553.* Dwessa, iv.1938, *Rayment 218.* Port St. Johns, 28.vii.1938, *Pocock & Papenfuss 243.* NATAL. Port Shepstone, 27.vii.1938, *Pocock & Papenfuss 242.* Umtwalumi River Mouth, 25.xii.1938, *Ecol. Surv. M.1.B.* Isipingo, 3.vii.1935, *Ecol. Surv. D.36.* Umhlali (Salt Rock Beach), 24.ix.1953, *Isaac B. 488.* Umpangazi, 2.v.1939, *Ecol. Surv. G.2.A.* St. Lucia Rocks (Crayfish Point), 21.vii.1938, *Pocock & Papenfuss 234.* MOZAMBIQUE. Vila de João Belo, near mouth of Limpopo River, viii.1936, *G. C. Nel.*

C. duthieae was picked up by many of the earlier collectors, but it was not distinguished from *C. tomentosum.* Setchell recognized it as a distinct species and annotated herbarium sheets *C. duthieae*, commemorating Dr. A. V. Duthie, who had sent him many collections of this, as well as other, species of *Codium.* This name remained a *nomen nudum* until 1956.

C. duthieae exhibits a wide range of variability in both habit and anatomy which parallels that found in its close relative, *C. decorticatum* (Woodw.) Howe. A statistical analysis of this variation pattern would be desirable, but even in the absence of such a study, certain observations seem warranted. There is a tendency for the dichotomies to be flattened, especially in plants growing in protected localities. Thus, specimens from Saldanha Bay and False Bay are markedly flattened and expanded. The juxtaposition in several localities of loose-textured plants with enormous utricles and relatively firm plants with smaller utricles would seem to indicate that differences in the size of utricles are not due to environmental differences. I suspect that age difference is more important than genic difference as a factor in this variability, although no supporting evidence is available at this time. Occasionally, plants with unusually small utricles are encountered, but these can be recognized in that the proportions and details characteristic of normal-sized utricles are retained. Plants along the Natal coast generally have utricles which are stouter and with more rounded apices than those farther west.

C. duthieae grows usually in the deeper pools of the sublittoral fringe and lower littoral zone, occasionally in open shallow bays (as at Salt Vlei Bay).

18. **Codium isaacii** sp. nov. [Fig. 19, Plate XVI, *b*]

C. tomentosum var. *capense* J. E. Areschoug, Nova Acta Reg. Soc. Sc. Upsal. III, 1: 368 (1854). "Ad Caput bonae spei, frequentissime."

Records Under Incorrect Determinations.—Harvey 1838, p. 404, as *C. tomentosum*, pro parte ("C. b. sp.," *Harvey*, AG). Drège 1843, pp. 109 and 111, as *C. tomentosum*, pro parte (see "Unverified Records"). Areschoug 1851, p. 6, as *C. tomentosum*, Drège reference only, pro parte. Stephenson, Stephenson, and Day 1940, p. 355, as *C. duthieae* (identity inferred from locality). Stephenson 1944, pp. 336 and 349, as *C. duthieae*, pro parte (Paternoster, *Ecol. Surv. P.4.D*). Stephenson 1947, pp. 283 and 296, as *C. duthieae*, pro parte. Silva and Womersley 1956, fig. 10*d*, as *C. duthieae*.

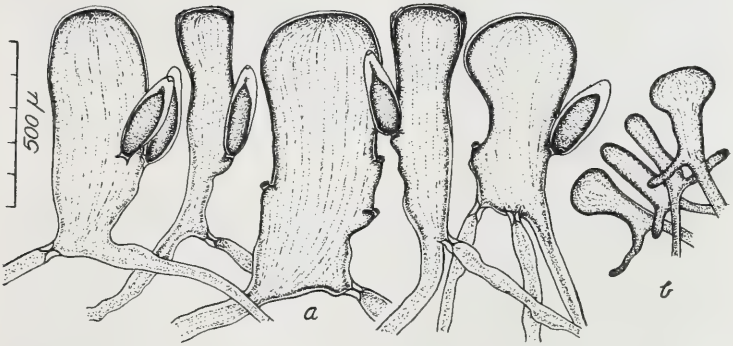

FIG. 19.—*C. isaacii* (Melkbosch, C.P., *Papenfuss 358*=type). *a*, utricles from standard sample; *b*, utricles from tip of thallus.

Thallus erectus ad 20 cm. alt., dichotome ramosus (ad octies), interdum subfastigiatus; rami teretes, ad basim 6 mm. diam., prope apicem ad 2·5—3 mm. attenuati. Thallus extrinsecus in utriculos singulos dissectus; utriculi subcylindrici ad clavatos aut pyriformes, crassi, 185—400 (—590) μ diam., 500—900 (—1,050) μ long., 1·3—3 (—3·5) plo longiores quam lati, apicibus rotundatis; membrana utricularis ad basim utriculi 2 μ crass., ad apicem gradatim incrassata; apex modice (—30 μ) ad valde (—70 μ) incrassatus, manifeste lamellatus, per strata exteriora rupta atque desquamata asperatus. Pili aut pilorum cicatrices non observati. Filamenta medullaria plerumque 35—75 μ diam., 2—4 e basi utriculorum vetustiorum emissa. Gametangia ellipsoidea aut crasse fusiformia aut lanceo-ovata, 78—150 μ diam., 260—365 μ long., aliquot per utriculum, omnia in pediculis 8—14 μ long., in protuberatione conspicua 390—615 μ infra apicem (triente utriculi inferiore) portata.

Thallus erect, to 20 cm. high, dichotomously branched (to 8 orders), at times subfastigiate; branches terete, 6 mm. diam. at base, tapering to 2·5—3 mm. diam. at apices. Thallus dissecting out into individual utricles; utricles subcylindrical to clavate or pyriform, stout, 185—400 (—590) μ diam., 500—900 (—1,050) μ long, 1·3—3 (—3·5) x long as broad, with rounded apices; utricular wall 2 μ thick at base of utricle, gradually thickening toward apex; apex moderately (—30 μ) to markedly (—70 μ) thickened, conspicuously lamellate, roughened by rupturing and sloughing of outer layers. Hairs or hair scars not observed. Medullary filaments mostly 35—75 μ diam., usually 2—4 emitting from base of older utricles. Gametangia ellipsoidal, stoutly fusiform, or lance-ovoid, 7 8—150 μ diam., 260—365 μ long, several per utricle, each borne on pedicel 8—14 μ long on conspicuous protuberance 390—615 μ below apex (lower third of utricle).

Type.—Melkbosch, Cape Province, 28.ix.1935, *Papenfuss 358* (UC).

Known Range.—Lüderitz, South West Africa, to Table Bay, Cape Province.

Representative Collections Examined.—SOUTH WEST AFRICA. Lüderitz, 26.vii.1957, *Isaac I.1111.* SOUTH AFRICA. CAPE PROVINCE. Port Nolloth, 4.x.1947, *Rodin 1505.* Paternoster, 3.i.1938, *Papenfuss 253*; 19.ii.1939, *Ecol. Surv. P.4.D.* Melkbosch, 27.i.1937, *Papenfuss 13.* Table Bay, *Pappe 68* (AG).

This species, though anatomically definable, is not especially distinctive. From considerations of the general shape of the utricles and of the size, shape, number, and position of the gametangia, one would be led to assign this material to *C. duthieae* as a form with small utricles. Careful study has revealed several significant differences, however, which are consistent throughout the range. The utricles are smaller and stouter; the position of the gametangia relative to the apex of the utricle being the same in both species, the shorter utricles of *C. isaacii* cause the gametangia to be borne strikingly lower. Hairs apparently are absent. The utricular wall thickens noticeably from the base upward, so that the upper third of the utricle (and especially the apex) is usually conspicuously thickened and lamellate. During development of this thickening, the outer layers rupture and slough off from the apex, which thus remains rough and with jagged edges along its shoulders.

C. isaacii appears to be the only strictly cold-water species of *Codium* in South Africa. Although it shares its territory with *C. fragile* subsp. *capense*, the latter ranges eastward into somewhat warmer waters as far

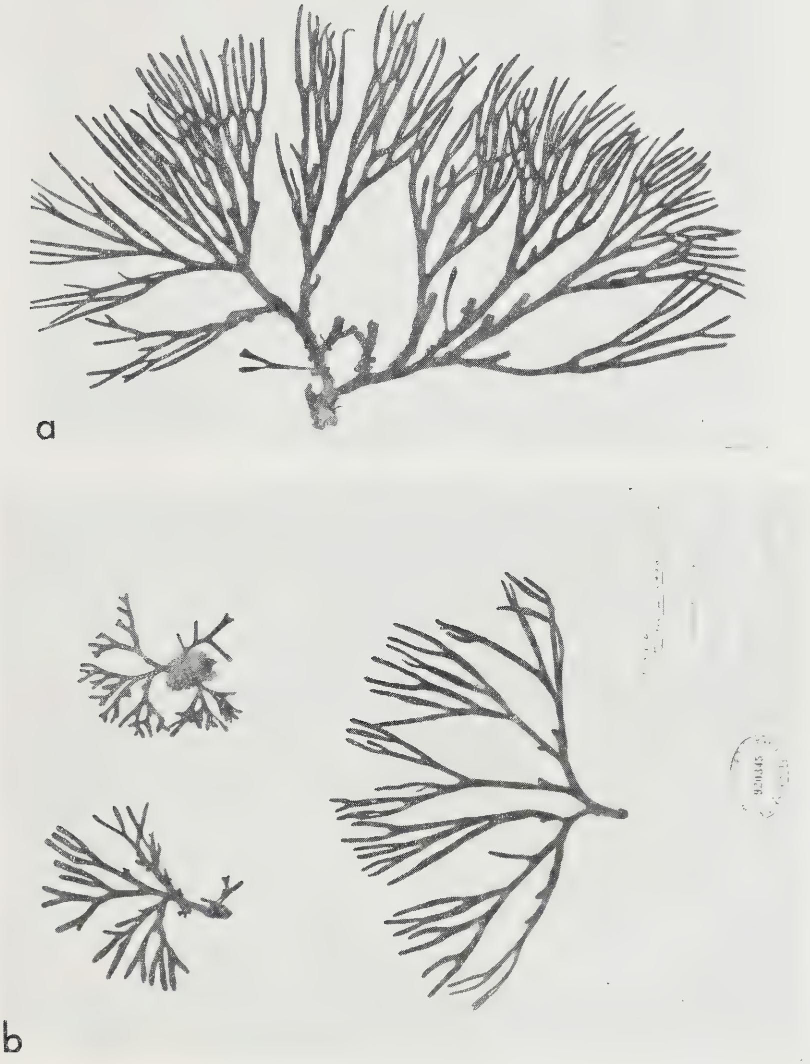

PLATE XVI.

a, *Codium fragile* subsp. *capense* (Melkbosch, C.P., *Papenfuss 12*=holotype); *b*, *Codium isaacii* (Melkbosch, C.P., *Papenfuss 358*=holotype).

as Robberg. At Saldanha Bay, an insolated area, *C. duthieae*, a species of warmer waters, intrudes into the range of *C. isaacii.*

Various herbaria contain specimens annotated "*Codium tomentosum*" or "*Codium tomentosum* var. *capense*" which probably, although not positively, were seen by Areschoug before he described this variety. These include representatives of *C. extricatum* ("Cap," *Zeyher*, S), *C. tenue* (Algoa Bay, *Zeyher*, S), *C. capitatum* (Port Natal, *Krauss*, AG), *C. isaacii* ("in sinu tabulari vulgare," *Pappe 68*, AG), *C. duthieae* (Table Bay, *Pappe*, S), and *C. fragile* subsp. *capense* ("Cap. b. spei," *Herb. Aresch.*, PC). In the absence of figures and explicit annotations on herbarium sheets, Areschoug's description is our only guide to the selection of a lectotype, and unfortunately it is not sufficiently diagnostic to remove all doubt. Only three species fit his statement that upon drying the thallus becomes verruculose: *C. duthieae*, *C. isaacii*, and *C. fragile*, of which *C. duthieae* is most conspicuously verruculose. The size of the utricles specified by Areschoug (>200 μ diam., 800 μ long), however, points more to *C. isaacii* and *C. fragile*. Areschoug stated that the utricular wall is far thicker than in "typical *C. tomentosum*," but did not mention mucronate apices. Hence, *C. isaacii* would seem to be the species to which the description best applies, and as lectotype I select the Pappe specimen from Table Bay in Herb. Agardh. (No. 15561).

In naming this species after Professor Isaac, I welcome the opportunity to commemorate his notable contributions to our knowledge of the distribution of South African seaweeds and to express appreciation for his kind help in the carrying out of this study and in the publication of the manuscript.

19. **Codium fragile** (Sur.) Har. subsp. **capense** subsp. nov. [Figs. 20 and 21, Plate XVI *a*]

Previous South African Records.—Rudolphi 1831, p. 179, as *C. tomentosum* (see "Unverified Records"). Suhr 1834, p. 737, as *C. tomentosum*, "Cap" record only, pro parte (Capetown, *Ecklon*, S). Harvey 1838, p. 404, as *C. tomentosum*, pro parte (Sea Point, *W. H. Harvey*, TCD). Drège 1843, pp. 107 and 111, as *C. tomentosum*, pro parte (see "Unverified Records"). Krauss 1846, p. 214, as *C. tomentosum*, Table Bay record only ("Cap d. g. Hoffnung," *Krauss*, HBG). Areschoug 1851, p. 6, as *C. tomentosum*, Rudolphi reference; Drège reference, pro parte; and Krauss reference, pro parte. Barton 1893, p. 82, as *C. tomentosum*, pro parte (St. James, False Bay, *C. G. Reynolds*, BM; "C. b. spei, 1774," *Brand*, BM); as *C. lindenbergii* (Cape of Good Hope, 1884, *Herb. Dickie*, BM). Barton 1896, p. 194, as *C. mucronatum*. Reinbold 1908, p. 187, as *C. mucronatum*. Delf 1921, pp. 58 and 62, as *C. tomentosum*, pro parte

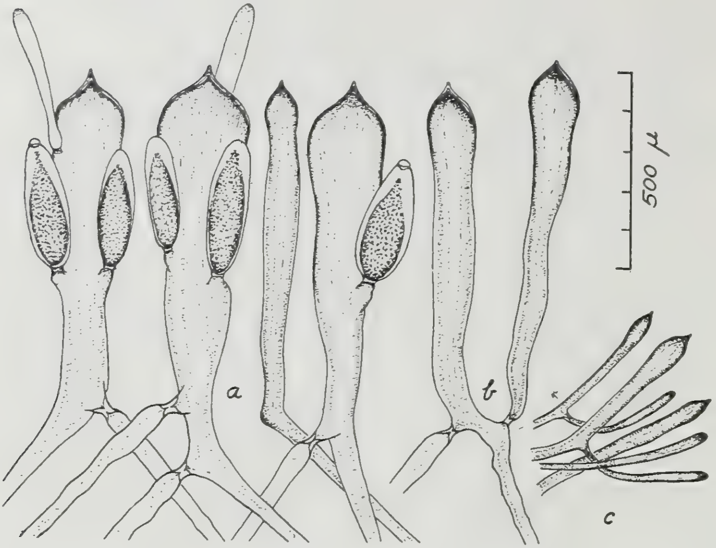

Fig. 20.—*C. fragile* subsp. *capense* (Danger Point, C.P., *Ecol. Surv. DP.1.A*) *a*, utricles from standard sample; *b*, utricles from lower part of thallus; *c*, utricles from tip of thallus.

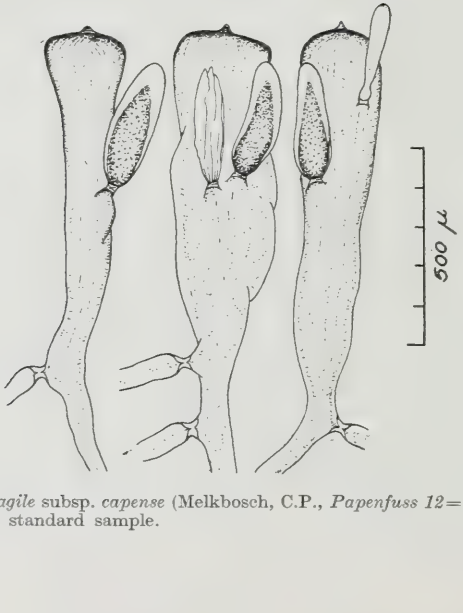

Fig. 21.—*C. fragile* subsp. *capense* (Melkbosch, C.P., *Papenfuss 12*=type). Utricles from standard sample.

(see "Unverified Records"). The following records are as *C. fragile*: Schmidt 1923, p. 47, Table Bay (*Krauss*, HBG) record only. Isaac 1937*b*, pp. 130, 133, 141, and 142. Bright 1938, pp. 77 and 78. Eyre 1939, p. 296. Pocock 1939, p. 78. Stephenson, Stephenson, and Day 1940, pp. 355 and 366. Isaac 1942, p. 234. Stephenson 1944, pp. 336 and 349. Isaac 1949, pp. 132 and 141. Stephenson 1947, pp. 283 and 296.

Excluded Records.—Schmidt 1923, p. 47, as *C. fragile*, Natal record only (Isipingo, 1894, *A. Weber-van Bosse*, NY); Silva 1951, p. 96. The material upon which these records are based is referable to *C. fragile* subsp. *capense*, but undoubtedly was not collected at Isipingo.

Thallus e frondibus erectis dichotomo-fastigiate ramosis 10—30 cm. alt., substrato per discum basalem latum spongiosum affixus, constat; rami omnino teretes aut in parte thalli inferiore paululum complanati, ad basim 5—8 (—14) mm. lat., prope apicem ad 3 mm. attenuati, atrovirides, raro proliferi. Thallus extrinsecus in utriculos singulos dissectus; utriculi clavati, (80—) 130—270 (—355) μ diam., 730—1,100 μ long., plurimum 3—6 plo longiores quam lati; apices acuminati; membrana utricularis 1·5—2 μ crass., ad apicem incrassata, acumine in mucronem acutum ad 60 μ long. producto; mucro partes interiores habens, lamellatus, interdum striationes concentricas praebens, adultus obtusus saepe factus. Pili crassi, sursum gradatim expansi; cicatrices pilorum frequentes, plerumque 1 vel 2 (—3) per utriculum, in zona 160—235 μ infra apicem portati. Filamenta medullaria plurimum 26—46 μ diam. Gametangia lanceo-ovata aut ellipsoidea aut cylindrica, 70—130 μ diam., 275—460 μ long., 1—3 per utriculum, omnia in pediculis 10—28 μ long. in protuberatione 430—630 μ infra utriculi apicem portata.

Thallus bushy, firm, very dark green, comprising one to several erect, dichotomo-fastigiately branched fronds 10—30 cm. high, attached to substratum by broad, spongy, basal disk; branches terete throughout or slightly flattened in lower part of thallus, 5—8 (—14) mm. broad at base, tapering to 3 mm. at apices, dark green, at times proliferous. Thallus dissecting out into individual utricles; utricles clavate, (80—) 130—270 (—355) μ diam., 730—1,100 μ long, mostly 3—6 x long as broad; apices pointed; utricular wall 1·5—2 μ thick, at apex thickened and prolonging point into sharp mucro to 60 μ long; mucro chambered, lamellate, sometimes with concentric striations, often becoming blunt with age. Hairs stout, gradually expanding upward; hair scars common, usually 1—2 (—3) per utricle, borne in zone 160—235 μ below apex. Medullary filaments mostly 26—46 μ diam. Gametangia lance-ovoid, ellipsoidal, or cylindrical, 70—130 μ diam., 275—460 μ long, 1—3 per utricle, each borne on pedicel 10—28 μ long on protuberance 430—630 μ below apex of utricle.

Type.—Melkbosch, Cape Province, 27.i.1937, *Papenfuss 12* (UC; isotypes in AD, BM, BOL, L, MAP, SAP).

Known Range.—Swakopmund, South West Africa, around the Cape of Good Hope to Robberg, Cape Province.

Representative Collections Examined.—SOUTH WEST AFRICA. Swakopmund, 31.x.1947, *Rodin 2172.* Lüderitz, 26.vii.1957, *Isaac B.502* (WEI). SOUTH AFRICA. CAPE PROVINCE. Port Nolloth, 4.x.1947, *Rodin 1505b.* Buffels River Mouth, 22.ii.1940, *Ecol. Surv. BR.1.D* Hondeklip Bay, 8.ii.1940, *Ecol. Surv. HB.3.A.* Groen River Mouth. 7.iii.1940, *Ecol. Surv. GR.3.A.* Zout River Mouth, 19.iv.1940, *Ecol. Surv, ZR.2.A.* Lamberts Bay, 5.i.1938, *Papenfuss 381.* Steenbergs Cove. 22.ii.1939, *Ecol. Surv. C.4.A.* Paternoster, 10.ii.1939, *Ecol. Surv. P.5.E.* Hoedjes Point, 2.i.1938, *Papenfuss 377.* Langebaan, 3.iii.1938, *Papenfuss 256.* Yzerfontein, 5.iv.1940, *Ecol. Surv. YZ.1.A.* Melkbosch, 28.ix.1935, *Papenfuss 379.* Blaauwberg, 27.iv.1939, *Pocock 1075.* Mouille Point, 18.v.1938, *Papenfuss 378.* Three Anchor Bay, 20.x.1935, *Papenfuss 25.* Sea Point, 18.v.1927, *W. A. Setchell.* Hout Bay, 3.vi.1939, *Pocock 1461.* Kommetje, 13.x.1935, *Papenfuss 380.* False Bay: St. James, 6.xi.1935, *Papenfuss 390*; Muizenberg, iv.1930, *Purcell 30* (K); Strandfontein, 24.xi.1936, *Papenfuss 22*; Somerset Strand, x.1937, *J. H. Stander*; Steenbras River Mouth, iv.1937, *T. F. de Waal.* Cape Hangklip, 8.i.1940, *Ecol. Surv. CH.1.R, CH.3.R.* Gans Bay, i.1946, *Isaac I.463,* Danger Point, 5.vii.1939, *Ecol. Surv. DP.1.A.* Cape Agulhas, 25.ii.1937, *Papenfuss 87.* Arniston, 20.ii.1939, *Pocock 529.* Robberg, 4.vi.1939, *Ecol. Surv. RR.1.J.*

The South African populations of *C. fragile* exhibit sufficient anatomical uniformity and distinctness to be set apart as a subspecies. The apices of utricles are broadly rounded, at times suggesting a German helmet. Although it is premature to discuss infraspecific relationships in *C. fragile*, subsp. *capense* would seem to be more closely related to subsp. *tomentosoides* (Europe, originally from Japan ?) than to those subspecies which inhabit other Southern Hemisphere regions (Australia, New Zealand, Patagonia).

C. fragile was picked up by many of the earlier collectors in South Africa, but was not distinguished from *C. tomentosum.* The first recognizable reference to it is Harvey (1838, p. 404): "The apices of the filaments of its periphery are sometimes mucronate, which no one appears to have noticed." It is interesting to note that in Herb. Kew. there is a specimen with the following data: "Cap de Bonne Espérance. ex Herb. Berk. 6/89. *Codium acuminatum* Crouan in herb. Les filaments qui composent la fronde sont tous acuminés au sommet; au lieu d'être arrondis comme dans le *Codium dichotomum.*"

In South Africa *C. fragile* grows in pools and channels of the lower littoral zone and sublittoral fringe. It is reported also from the lower part of the Granularis (Balanoid) zone of Lamberts Bay (Stephenson, Stephenson, and Day). It is not known with certainty from the region between Arniston and Robberg.

EXCLUDED SPECIES

In addition to the various species which have been erroneously attributed to South Africa on the basis of incorrect identifications, and which are cited in the treatment of the proper species, the South African record of the following species probably is based on erroneous labelling:

Codium galeatum J. Agardh, Lunds Univ. Årsskr. 23 (Afd. 3, Nr 2): 42, pl. 1, fig. 1 (1887). Reinbold 1908, p. 188.

Collections Allegedly from South Africa.—CAPE PROVINCE. Knysna, 1894, *A. Weber-von Bosse* (L). "Cap," *Herb. Reinbold.* (HBG).

I had dismissed the Reinbold report as an error attributable to interchange of labels (material from Australia and South Africa having been studied simultaneously) until the discovery (in 1950) in the Rijksherbarium, Leiden, of *C. galeatum* intermixed with *C. fragile* in a packet assertedly collected by Mme. Weber-van Bosse at Knysna in 1894. The question whether this distinctive Australian species also occurs in South Africa was thus re-opened, but after an intensive study of *C. fragile* from both South Africa and Australia, it is possible to say with certainty that the Weber-van Bosse packet contains material collected in Australia rather than in South Africa, and more precisely that probably it was collected in the Melbourne region.

UNVERIFIED RECORDS

The specimens upon which the following records are based have not been located with certainty:

Rudolphi 1831, p. 179, *Codium tomentosum*, "Van Camps-bai. Juli," *Ecklon.* Although no Ecklon specimen from Camps Bay has been located, one allegedly from Cape Town, referable to *C. fragile* subsp. *capense*, is housed at Stockholm. The description, "fronde dichotoma fastigiata cylindrica," strongly suggests that species.

Drège 1843, p. 107, *Codium tomentosum*, "Strandfontein, bei der Mündung der Olifantrivier, November"; p. 111, *C. tomentosum*, "Tafelbaai, bei der Stadt und auf Paardeneiland, Mai, Juni." Three specimens have been found, any of which might have been collected at the specified localities: "Cap de bonne espérance, 1839," *Drège* (L)=*C. isaacii:* "Port Natal et S. Afr., reçu 1838," *Drège* (G)=*C. fragile* subsp. *capense*; "leg. *Drège*" (HBG)=*C. fragile* subsp. *capense.* Another Drège specimen at Genève, labelled "Kaffernküste," is referable to *C. duthieae.*

Barton 1893, p. 82, *Codium tomentosum*, Table Bay, *L. Boodle*, and Cape of Good Hope, 1884, *Herb. Dickie.* Both specimens are in the British Museum and were determined by me as *C. duthieae* in 1950, but recent studies have opened the possibility that they might be referable to *C. isaacii.* Unfortunately, they have been misplaced and thus are not available for restudy.

Barton 1893, p. 82, *Codium tomentosum*, Sea Point, *L. Boodle* [almost certainly either *C. duthieae* or *C. fragile* subsp. *capense*]. Barton 1896, p. 193, *Codium bursa*, Natal, *M. Evans* [probably either *C. megalophysum* or *C. papenfussii*]. Both of these references are based on specimens presumably housed in the British Museum, although they have not yet been located.

Reinbold 1908, p. 188, *Codium tomentosum*, "Kap d. g. H." The specimens upon which this record is based presumably were at Berlin and were destroyed in 1943.

Delf 1921, pp. 58 and 62, *Codium tomentosum*, "west coast of the Cape Peninsula." Almost certainly either *C. duthieae* or *C. fragile* subsp. *capense* or both.

Delf and Michell 1921, p. 95, *Codium tomentosum*, Algoa Bay and Knysna; *Codium lindenbergii*, Cape Morgan.

PHYTOGEOGRAPHIC RELATIONSHIPS

The *Codium* flora of South Africa shows a remarkably high degree of endemism. Of the sixteen species found along the shores of the Union (that is, excluding the three species treated in this paper which occur in Mozambique but not in the Union and which range an unknown distance northward along the east coast of Africa), eleven are known only from the Union while one [*C. isaacii*] occurs also in adjacent South West Africa. With reference to their centre of distribution (cf. Fig. 22), these endemic species may be listed as follows, from west to east: *C. isaacii*, *C. stephensiae*, *C. incognitum*, *C. papenfussii*, *C. platylobium*, *C. pelliculare*, *C. tenue*, *C. extricatum*, *C. megalophysum*, *C. prostratum*, *C. capitatum*, and *C. pocockiae.* All of the remaining species occur also in Australia: *C. lucasii*, *C. fragile*, *C. duthieae*, and *C. spongiosum.* Of these non-endemic species, *C. lucasii* and *C. fragile* are sufficiently distinct in South Africa to warrant subspecific recognition. *C. spongiosum* is Indo-Pacific in affinity, whereas the *C. fragile* complex is widely distributed, being pan-temperate, bipolar, as well as antarctic circumpolar.

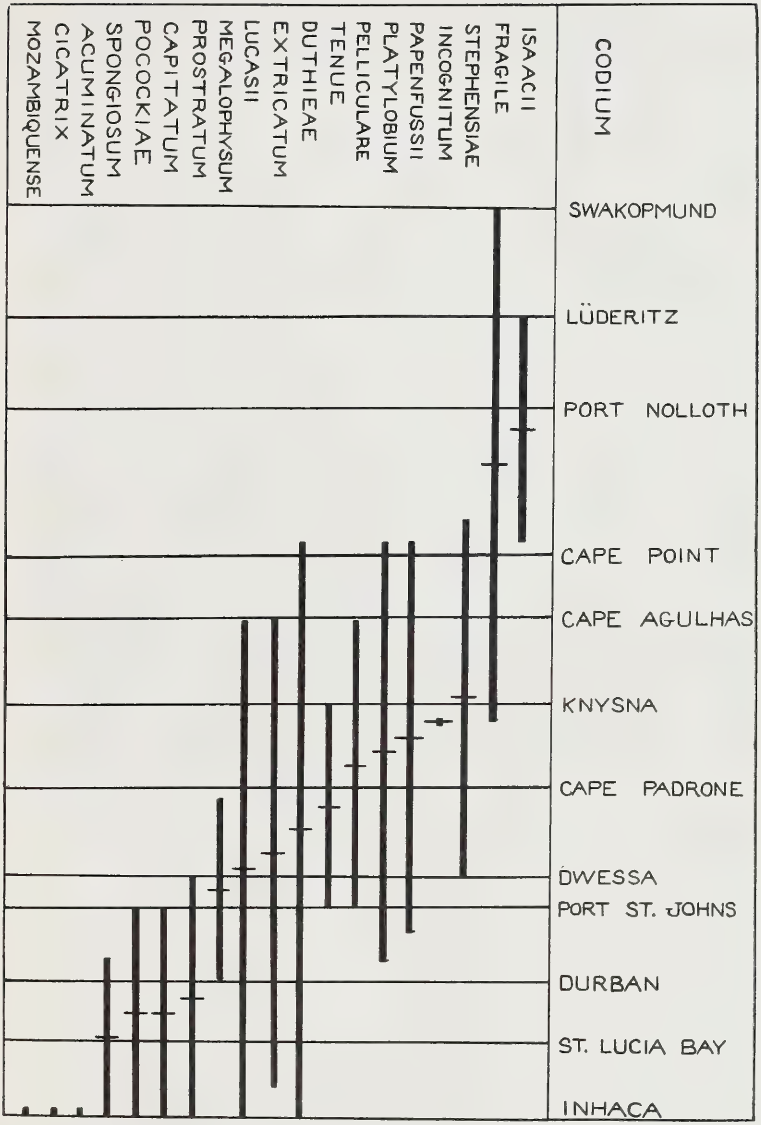

Fig. 22.—Graphic representation of the geographic ranges of the various species of *Codium* in southern Africa. Species are arranged according to their centre of distribution.

In examining the known ranges of the various species, one is immediately impressed by the correlation of range limits with three areas: Kommetje—Cape Town, Cape Agulhas, and Dwessa—Port St. Johns. Isaac (1937*a*, 1938) has ably discussed the hydrography of South Africa and the relationship of its features to the distribution of seaweeds. While there is no need to review the subject in its entirety, it may be worthwhile briefly to consider hydrography as an explanation of the effect of these three areas in limiting the ranges of various species of *Codium*.

On the east coast, the South Equatorial Current, flowing westward as part of the general anticyclonic circulation in the southern Indian Ocean, is divided into two branches by the intervention of Madagascar. The northern branch flows around the north end of that island and, in the region of Cabo Delgado on the east coast of Africa, again splits, one branch flowing northward and the other, the Mozambique Current, flowing southward close to the coast of Africa. In the region of Delagoa Bay, the Mozambique Current is joined by part of that branch of the South Equatorial Current which earlier was deflected to the southwest by Madagascar. The confluence of the two currents forms the swift-flowing warm Agulhas Stream, which continues close to the coast as far as Knysna Heads, where it is deflected slightly seaward by the Agulhas Bank, upon which it impinges. From the longitude of Knysna Heads westward the Agulhas Bank becomes broader, first gradually, then markedly, extending over 100 miles seaward south-east of Cape Agulhas. Accordingly, the greater part of the Agulhas Stream is deflected first to the south, then to the south-east, after which it returns to the circulation of the Indian Ocean. A small part of the Agulhas Stream flows both over and around the Agulhas Bank to the region between Cape Agulhas and the Cape of Good Hope. Some idea of the resulting temperature gradient is given by the following data: Durban has a mean annual surface sea temperature of 21.8° C., a maximum mean monthly temperature (Feb.) of 24.65°, and a minimum mean monthly temperature (Aug.) of 19.25°; for Port St. Johns the corresponding figures are 19.3°, 21° (Jan.), and 16.8° (July); for East London the corresponding figures are 17.6°, 19.15° (Jan.), and 15.7° (Sept.); for Knysna Heads the corresponding figures are 16.8°, 19.85° (Feb.), and 13.5° (Aug.). The Dwessa—Port St. Johns area undoubtedly is merely a stretch of coast where the maximum and minimum temperatures of intertidal and upper sublittoral water exceed the limits of tolerance of several species, in both directions: in this region the eastward limit is reached by *C. stephensiae*, *C. pelliculare*, and *C. tenue*, the westward limit by *C. prostratum*, *C. capitatum*, and *C. pocockiae*. In this instance a relatively straight coast with uniform temperature gradient cumulatively has the same effect as conspicuous physiographic barrier. The distribution of *Codium* confirms Stephenson's (1944, p. 279) assessment of the biogeographic importance of this area, although he found the effect more apparent among animals than among seaweeds.

On the west coast, under the influence of the prevailing southerly and south-easterly winds, the surface layers of water are carried away from the coast, and upwelling of cold water from moderate depths (Antarctic Intermediate Water) takes place in most seasons. This portion of the anticyclonic circulation of the South Atlantic Ocean, called the Benguela Current, establishes a temperature gradient of such a nature that the region of coldest inshore water lies between Hondeklip Bay and Lüderitz Bay, moving north and south over a distance of 280 miles during the year. At Cape Town* the mean annual surface sea temperature is 12.8°, the maximum mean monthly temperature is 13.6° (Dec., Jan., Apr.), and the minimum mean monthly temperature 12.4° (Sept.); the corresponding figures for Walvis Bay, just within the tropics, are 16.1°, 18.4° (Jan.), and 13.4° (July). Approximate mean annual temperatures of some intermediate localities are Hondeklip Bay, 12.04°; Port Nolloth, 12.3°; and Lüderitz Bay, 13.1°. The outstanding local deviation from this gradient is Saldanha Bay (mean annual temperature, 14.8°), a large, nearly land-locked lagoon which is subject to a high degree of insolation (Isaac 1956). Correlating the distribution of *Codium* with this temperature pattern, we should note that *C. fragile* occurs at least as far north as Swakopmund, just north of Walvis Bay, the only known record for this species within the tropics. Although temperature data for the eastern limit (Robberg) of this species are not available, comparison with data for nearby Knysna Heads (cf. above) would suggest that Swakopmund is approximately its northern limit. *C. isaacii*, judging from temperature data for its southern limit (Cape Town), probably does not extend much (if any) beyond Lüderitz, its presently known northern limit. The relatively warm water of Saldanha Bay accounts for more northerly stands of *C. duthieae* and *C. stephensiae* than might otherwise be expected.

At one time the Cape Peninsula was considered a physiographic barrier of major phytogeographic importance due to its separation of the cold west coast and warm east coast currents. From the work of Isaac and of the Ecological Survey, particularly, it is now known that the phytogeographic importance of the Cape, although not greatly exaggerated previously, does not have such a simple hydrographic explanation nor is it manifested in such a simple floristic manner. The marked differences between sea surface temperatures of the two sides of the Cape Peninsula

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*Temperature data for Cape Town were taken at Cape Town Pier, which no longer exists because of shore reclamation.

(for Muizenberg the figures corresponding to those given above for Cape Town Pier are 16.6°, 19.6° [Dec.], and 13.1° [June]), especially in summer, must be accounted for by considering False Bay a pocket of warm water resulting from insolation and wind drift which interrupts the decreasing temperature gradient which otherwise would continue from Knysna Heads to Cape Point. The west side of the Cape Peninsula thus has essentially a cold-water flora with an increasing admixture of south coast species toward Cape Point, while the east side has an essentially south coast flora with an admixture of west coast species decreasing away from Cape Point. In this region of rapid transition *C. isaacii* reaches its southern limit while *C. papenfussii* and *C. platylobium* reach their western limit.

The hydrography of the south coast is complex. The region from Knysna Heads west to Cape Point is not directly under the influence of the main portion of either the Benguela Current or the Agulhas Stream, although a small part of the former enters False Bay, especially in winter, and small branches of the latter enter the region from the east. Wind, acting in conjunction with the configuration of the coast, has a marked influence on the temperature of these coastal waters. The prevailing south-east winds of summer pile up warmer surface waters against those shores whose configuration is such that these waters are entrapped, as at Cape Agulhas and Struis Bay. The same winds, however, blow the warmer surface waters away from those shores which trend in a direction more or less parallel to that of the wind, causing upwelling of cold water. This accounts for the marked difference in the maximum mean monthly temperature (summertime) between the two sides of Cape Agulhas (as well as between the two sides of the Cape Peninsula), and thus explains why such capes are effective barriers to the eastward spread of cold-water forms and to the westward spread of warm-water forms. The maximum mean monthly temperature of Cape Agulhas is 20.9° (Jan.), the same as at adjacent Struis Bay and higher than that of any locality east to Port St. Johns. The mean annual temperature of 17.7° for Cape Agulhas thus is higher than would be expected were the east coast gradient to continue uniformly from Knysna Heads. By contrast, the maximum mean monthly temperature of Danger Point, just west of Cape Agulhas, is only 17.1° (Jan.), indicating summertime upwelling. The lower temperatures west of Cape Agulhas apparently are critical to three species of *Codium*, which reach their westward limit in this region: *C. extricatum*, *C. lucasii*, and *C. pelliculare*.

In summary, on the basis of centre of distribution together with range limits, the South African species of *Codium* fall into the following geographic groups:

I. Species with centre of distribution in cold water [mean annual surface temperature approximately 12°—12.5°].
   - A. West coast cold-water species: *C. isaacii.*
   - B. West and south coast cold-water to cool-temperate species: *C. fragile.*

II. Species with centre of distribution in temperate water [mean annual surface temperature approximately 17°—19°].
   - A. South coast cool-temperate to warm-temperate species: *C. stephensiae*, *C. incognitum*, *C. papenfussii*, *C. platylobium*, *C. pelliculare*, *C. tenue*, *C. megalophysum.*
   - B. South and east coast cool-temperate to warm-temperate and subtropical species: *C. duthieae*, *C. extricatum*, *C. lucasii.*

III. Species with centre of distribution in warm water [mean annual surface temperature greater than 20°]:
   - A. East coast subtropical species: *C. prostratum*, *C. capitatum*, *C. pocockiae*, *C. spongiosum.*
   - [B. Subtropical to tropical species, ranging from Mozambique northward an unknown distance: *C. acuminatum*, *C. cicatrix*, *C. mozambiquense.*]

Finally, it may be noted that Cape Padrone, postulated by Stephenson as the dividing point between the east and south coasts, apparently has no effect on the *Codium* flora.

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